Vol. XVII.
No. CCCCXIV.]

OCTOBER 31, 1885.

[Price,
Fourpence.

NO 10 1885

# THE ELECTRICAL REVIEW

LONDON: PUBLISHING OFFICE, 22, PATERNOSTER ROW, E.C.—Subscription per annum, Postage inclusive, in Great Britain, 19s. 6d.; to Countries in Postal Union, of the first class, 21s. 8d.; of the second class (Aden, India, Persia, &c.), 23s. 10d.—New York: D. Van Nostrand, 23, Murray Street, and 27, Warren Street. Paris: Madame Veuve J. Boyveau, Librairie Etrangère, 22, Rue de la Banque. Berlin: A. Asher & Co., 5, Unter den Linden.

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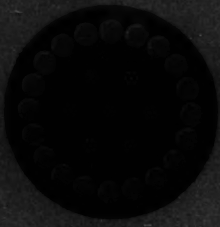

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THE TELEGRAPHIC JOURNAL AND
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VOL. XVII.—NO. 414.

# AMERICAN TELEPHONE PATENTS.

THOSE who have most recently sought to annul the Bell telephone patents in America have met with a curious rebuff. The President of the United States has taken a different view of the action of the Government legal officers to that which Mr. Van Benthuysen and his supporters hoped and expected he would, and has urged the Solicitor-General, who, during the absence of Mr. Garland, acted as Attorney-General, to consider whether his consent to the use of the name of the United States against Bell without previously referring to the Interior Department, was, as a precedent, in accordance with safety and propriety. Mr. Goode, the Solicitor-General, recognised in the President's communication a hint which he did not neglect to act upon, and he replied that although his omission to refer to the department was the result of a satisfactory persuasion, derived entirely from the papers presented to him, as to what was right and proper to be done, he yet concurred with the President as to the propriety of the practice which had been generally adopted in such matters, and, being unwilling to take any action which might be regarded as a departure from a wise and safe precedent, he considered that, under all the circumstances, it was perhaps best to revoke the permission which had been granted, and accordingly he had written to the Attorney of the Western District of Tennessee, directing him to discontinue the suit. Thus, what was expected to be the most effective antagonism of the Bell patents has resulted in a complete *fiasco;* and perhaps it is as well so, for there were circumstances in connection with the bringing of the suit which, as we have pointed out, did not lend at all a pleasant colouring to the matter. That the principal law officers of the State should have been closely connected with opposing interests was a sufficiently suspicious circumstance to account for the wrathful utterances which have gone forth; and, although the conduct of these gentlemen may have been above reproach, it is better all round that the course, somewhat hastily adopted, should be abandoned. President Cleveland was careful in his communication to Mr. Goode to refrain from expressing any opinion upon the merits of the case, confining himself to pointing out that there had been a departure from precedent which it might be advisable, under the special circumstances, to reconsider. It is, of course, quite open to the gentlemen of the National Improved Telephone Company to again move for the United States to take up the prosecution, in order that the application may go through the proper form and be granted or denied, according to the views of the officials of the Interior Department; but, after the unexpected check they have received, it is questionable whether they will do so.

# ELECTRIC LIGHTING IN THE UNITED STATES.

By CHARLES LEVER.

*(Concluded from page 332.)*

IT is not the least surprising to find that only the Brush system is used in the far west, since this was the pioneer system of electric arc lighting in America. Ever since Brush first showed the feasibility of working a large number of arc lamps in series from one dynamo machine, American electricians have kept rigidly in this groove. All the successful systems of arc lighting are on the same principle as the Brush, the lamps being of the differential clutch type, and the dynamos wound for high tension. As regards lamps themselves, the Hochhausen, Van Depoele and Fuller, which are of the clockwork type, are exceptions. The only attempt at striking out into a new field simply lies in the fact that one or two systems employ a small current with a long arc, whilst the others use a heavy current and a short arc. In the one case we have a light with a tendency to give out disagreeable blue rays, in the other a pleasant light accompanied by the usual hissing noise and occasional flickering. There is no happy medium. No experimenting appears to have been done in order to ascertain which is the most suitable current to use with a given diameter of carbon, and what is the proper length of arc to work with in order to give the best results. The fact that the positive carbon ought to have a well defined crater appears to have been overlooked. It is even rare to find an ammeter in circuit with the lamps in order to see that the right current is passing through them. Evidently it matters little whether the lamps are hissing or flickering so long as the lights are kept burning. That the lights can be depended upon is, however, shown by the fact that the gas is very rarely kept burning where such arc lights are in use, and where the gas is already laid on. The fact of so many copper-coated carbons being used in the arc lamps has, no doubt, a great deal to do with the unsteadiness of the lights. It has been argued that a copper-coated carbon is more durable than a plain carbon of the same diameter, although it has been proved, at the Boulton Carbon Company's works at Cleveland, that the reverse is really the case. Outside of this carbon question, however, it should be pointed out that the arc lamps themselves are by no means as regular in adjusting the carbons, or feeding, as those we are acquainted with in this country.

Of the American arc lamps the Hochhausen appears to give the steadiest light, and this company certainly deserves some praise for the neat manner in which the wires are put up in most of the installations on this system. But even an installation on the Hochhausen system would sink into insignificance as regards steadiness and purity of light, when compared with such an installation, for instance, as that which has been in operation for a few years past at the *Daily Telegraph* office, in Fleet Street; and, indeed, many others in this country too numerous to mention here. The light of the Hochhausen lamp could be much improved by the addition of two or three ampères more current than is generally used, and by employing better carbons. But, it is this eternal desire to get as many lamps in series from one machine as is possible, which no doubt prevents such a course from being adopted in regard to increment of current. Whatever may be the advantages of this high tension supply system, they are completely annulled by the element of danger introduced thereby. Despite all that may be argued to the contrary, men will continue to be killed in the future as in the past by such systems. Not that there is here an advocacy of the parallel system as applied to arc lighting. The series method is undoubtedly correct as long as the tension is kept within safe limits; but in America it is altogether carried to extreme. During the past two or three years the electromotive force of certain dynamos has risen, in that country, from 2,000 volts to 3,000 volts. In other words, 40 lighters have given way to 60 lighters. The danger already exists and would not be greater even if 100 lighters are built in the future.

Of course it should be stated that there are arc light circuits many miles in length in the United States, and this high tension system admirably fulfils the requirements *temporarily*. The word temporarily is here used advisedly, for it is a question whether the supply of thousands of arc lights to stores, &c., for advertising purposes alone, can be considered a healthy development of the electric light. Even the manner in which such installations are carried out, shows them to be of a temporary character. There are many people in the United States who have tried these arc lights for advertising purposes, and have discontinued them, and, on the other hand, there are others who stick to them when they find it pays them to do so.

Outside of this supply system it is, however, very satisfactory to see that the local authorities have adopted arc lights in the streets in most of the cities, and also that there are a vast number of isolated plants in operation. The reason why electric lighting has made such progress in the United States is not far to seek. In that country the gas is of an inferior quality, whilst the price is from four to six times as much as in England. Besides, the Americans are a go-ahead people. It is, however, this low price and excellent quality of gas which has made English electricians pay more attention to the details of arc lighting, and which has resulted in the production of better means of regulating the carbons, and consequently steadier lights, on this side of the Atlantic.

Before leaving the subject of arc lighting, some reference ought certainly to be made in regard to its latest development in the United States, *i.e.*, the tower system. A very few words will suffice on this point. If anyone wishes to light so many acres of prairie land in Nebraska, or so many square miles of sage brush plain in Nevada, then by all means let them adopt the tower system. But, for lighting a city, it is altogether a failure. In a city we want light, not mere moonlight effects, accompanied by weird and fantastic shadows. The efficient lighting of a city by means of arc lamps, can only be accomplished by placing them in the ordinary manner, and not so as to light the sky instead of the ground.

And now a few words in conclusion in regard to the development of the incandescent light in the United States. Some years ago, the late Mr. Sawyer, in conjunction with Mr. Mann, introduced an electric incandescent light system, in which a small carbon pencil was rendered incandescent in a glass globe containing nitrogen. This Sawyer-Mann system, as it was called, never made much headway. Indeed, it was not until Mr. Edison showed us the direction in which we were to work in order to make the incandescent system a practical undertaking and a commercial success, that any headway was really made.

Although the incandescent lamps themselves are no more efficient in America than they are here, yet, on the whole, incandescent light installations are there carried out in a much better manner than those in this country. In the States we don't find manufacturers claiming an efficiency of 2¼ watts per candle-power, but they supply good, substantial, and durable lamps, giving an honest sixteen candle-power. Neither do we find lamps of different voltage, some almost ready to burst with brightness, others dull with redness, in their installations, but lamps of uniform brilliancy. Probably this fact is to be attributed to the better methods of gauging filaments in America. That attention to detail, which has been omitted in arc lighting, has been bestowed in its entirety on incandescent lighting. The incandescent lampholders and fittings in the United States are altogether more substantial than those in England. Where have we a really substantial connection, in this country, for lampholders, with the exception of the Edison holder? The fact is that we want, in our incandescent light installations, more of the substantial and less of the flimsy, more of the practical and less of the theoretical, and more of the actual and less of the 105 per cent. efficiency business.

As regards working arc and incandescent lights together, it is an unfortunate thing that we, in England, have already advocates and admirers of the high tension supply system. During the past two years, a system has cropped up in the United States, whereby incandescent lamps are worked on the same circuit as the arc lights by means of high tension currents. An automatic arrangement is provided with each incandescent lamp, so that in the event of said lamp giving out, a resistance equivalent thereto is thrown in circuit. It is a system which has not made much headway, and it is to be hoped that it never will do. Notwithstanding the theoretical "bosh" which has been put forth by the advocates of the high tension system in this country, the practical electrician knows perfectly well that this is not the field to work in, if we are to make a success of our future electric light supply stations. As already stated, Mr. Edison has led the way by making his supply station in New York a practical undertaking and a commercial success. If we wish to be successful with the future electric light supply stations in this country, we should act wisely by following in his footsteps. And, when these lighting stations have developed into undertakings of any magnitude, the supply of electricity must eventually fall into the hands of the municipal authorities—as in the case of gas and water undertakings—in order to secure the best results for the public benefit.

## ELIHU THOMSON'S SYSTEM OF ELECTRIC DISTRIBUTION.

THIS invention relates to a certain improvement in the system of electric distribution in which an electric current on a circuit including the primary coils of a series of induction coils, induces in a set of secondary coils placed in inductive relation to the said primary coils, secondary or induced electric currents which are utilised to operate incandescent electric lamps or to do other work.

The invention is applicable also to other systems in which high potential circuits are employed in connection with apparatus normally insulated from said circuit, but liable to accidental connection therewith.

The invention consists in the application to such a system of a device whereby the danger to the consumers of light, or persons touching the secondary wires or local wires, may be averted, even though a very high potential be used upon the main or primary line.

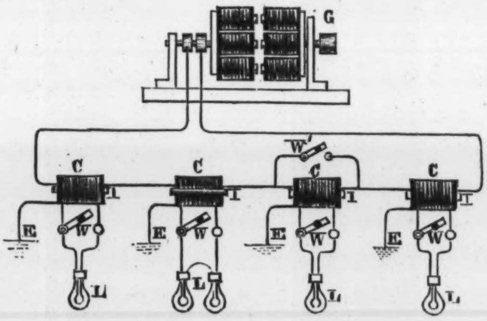


FIG. 1.

By means of this invention it is possible to supply, with entire safety to parties using the lights, one or more incandescent or other lights, supplied from secondary coils placed in or near the building, the primaries of which coils are connected to or into a main line upon which currents of very high potential may be employed, either alternating in character as delivered from the light station or generating station, or interrupted or alternated at each induction coil by suitable devices, such as have formed the subject of prior application for letters patent by Prof. Thomson, a continuous current being in such case supplied from a generator.

In fig. 1, G represents an alternating current generator, placed in a lighting station, operated by power at any convenient point, from which extend insulated mains or conductors, preferably placed underground in a suitable conduit or pipe filled with dry air and carried to the place of consumption, such as buildings in a city and other points, the conductors being kept carefully insulated throughout as far as possible. The conductors are carried at various points through the primary coils of a series of induction coils, C, C, C, C, wound around suitable iron cores, I, I, I, I, so that the primaries may magnetise the said cores and change their magnetism, as will be readily understood. Around each primary, or adjacent to it, is wound a suitable secondary coil for supplying current to the lights, L, L, L, L, or other apparatus, suitable switches, W, W, W, W, being provided to short circuit the secondary coils and extinguish the lights. With a system thus constituted, should the primaries be of great number and the current supplied of very high potential (which is necessary to economically transfer the energy to a very great distance from a generator, G, with moderate-sized conductors), and should any portion of the system become grounded or subject to a leakage to earth, a person touching the secondary coils, himself being grounded upon moist surfaces or in connection more or less completely with the earth, would, if the insulation between the primary and secondary coils were leaky or faulty, receive a severe if not a fatal shock.

The object of the present invention is to provide a complete safeguard against any such possibility; and although the inventor has illustrated the system in fig. 1 as using alternating currents upon the main line, he wishes it distinctly understood that his invention, so far as it affords a perfect safeguard from shocks or danger, is not limited to such a system, but may be applied to other systems, such as those employing continuous currents on a main line—as for instance, an arc-light line upon which induction coils with commutating or circuit-changing devices in the primary circuit are used. Prof. Thomson renders practicable a system the working of which would otherwise be fraught with great danger by an attachment which we will now describe. The secondary coil is wound with such coarse wire and the lamps used therewith are of such low volt potential as not in itself to produce dangerous discharges or shocks. He selects a point of attachment for a lower resistance, or a short and thick wire leading to the earth plate, E, in fig. 1, or gas or other mains, so as in any way to afford a secure ground. This attachment being provided for every secondary on the line, forms, practically, a shunt of no resistance around the body of the person, who might otherwise receive dangerous shocks by being grounded and touching a secondary wire in accidental leaking connection with the accidentally grounded main line. It is preferable in the system that the generator, G, be self-regulating in such a way as to permit switching one or more of the secondaries in the series, or the primary coils, as at W′, without affecting the intensity of action or light in the remaining lamps. Methods of accomplishing this result will form the subject of other applications, the present invention being chiefly concerned with the application of the ground connection, as will be further developed. It is not essential that the ground connection be attached to a secondary coil or circuit of a secondary coil, as it may be attached to a separate conductor suitably interposed as a sort of diaphragm between the secondary and primary coils, although insulated from or in connection with the secondary itself. Thus, in fig. 2, P, P, are primary coils in the main line, wound on the ends of the iron wire core, I, or other divided core, and S, a secondary coil, the terminals of which are indicated at *a*, *b*. The core, I, and primary, P, P, are thoroughly insulated by a layer of good insulating material placed between them, a layer also being interposed between the primary and secondary coils, so as to prevent leakage as far as possible; but as a further precaution two metallic diaphragms, D, D, are placed near the secondary coil, S, and connected to the earth plate, E, by a short good conductor. The core, I, in this case is preferably connected also either to the plates, D, D, or directly to the earth plate, E, or other ground connections, of which it is the representative. The form of the disc or diaphragm may be greatly varied. The disc constitutes a metallic septum insulated from the primary and insulated or not from the secondary, and by it any leakage from the primary, which would otherwise go to the secondary and connections, is intercepted and carried to the ground. In one form the disc or septum is modified to form a tube surrounding the primary with its layer of insulation. Outside of the tube the secondary is wound. In another it is shown as coarse wire forming a layer of the secondary coil, put to earth, and insulated from the primary by an interposed sheet or tube of good insulating material.

It will be obvious that the invention may be of service in its application to any other system of electric distribution in which currents of high tension flow over a main circuit.

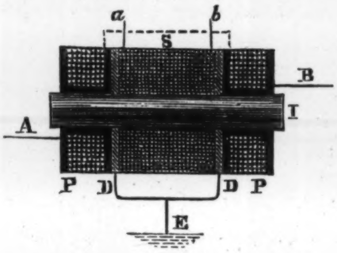


FIG. 2.

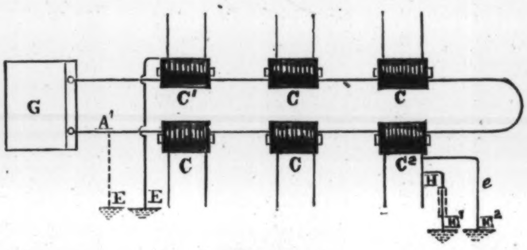


FIG. 3.

Fig. 3 illustrates the manner in which, if the earth connection be applied according to the invention, the danger of shock will be avoided. The generator, G, is supposed to be feeding the line containing coils arranged as described in fig. 1, with earth connections arranged as hereinbefore described. We will suppose that a leak or ground connection has accidentally been formed at some portion of the main line or circuit—as, for instance, at A′, near the generator—or that a leak has occurred from the main line through defective insulation of a coil, as at C′, and that the secondary circuit has been accidentally grounded, thus making a leak from the line circuit through the primary to the secondary coil and to ground. If at the same time defective insulation should exist at any other coil, as C², between the primary and secondary, and a person should touch the secondary, as at H, and at the same time be grounded in any way, as by contact with moist floors, or by touching a water pipe or other metallic surface of large extent in more or less complete connection with the ground, as indicated at E′, such a person would be included in a shunt around a part of the main line grounded, as at A′, or grounded through a leak from primary C′ to an accidental ground of the secondary, and would receive a discharge depending on the power of the primary current and the resistance between the point at which he received the discharge and the other ground or leak. With very high potential on the main line such a shock or discharge would possibly prove fatal. If, however, the secondary, as $C^2$, has been purposely grounded by a short thick wire, as $E^2$, the person would be saved all the injurious consequences, as a shunt of low resistance would then exist around his body. Such a ground connection being applied to all the coils in the circuit will effect a similar protection against all possible danger. At the same time lightning discharges accidentally reaching the main line cannot produce injury upon the secondary line.

It is manifest that where, as in fig. 2, the ground connection is made to a metallic diaphragm interposed between the primary and secondary coils an equally efficient, if not more efficient, protection from effects of leakage from the primary will be obtained.

## ACCUMULATOR-ELECTRODES.

By EMILE REYNIER, in *L'Electrician.*

ALTHOUGH strongly attacked by certain electricians, the new chemical theory of accumulators which I have put forward in this journal, is at present generally accepted. No objection, based upon experiment, has been urged against it; on the contrary, facts daily testify in its favour. Thus, MM. Crova and Garbe, have experimentally proved the fixation of one equivalent of sulphuric acid upon each electrode during the discharge, and M. Tscheltgow, after having measured the formation heat of the peroxide of lead, has furnished the new theory with a thermo-chemical verification which was otherwise foreseen.

It is known that I did not wait for these late confirmations to admit double sulphatation in the solution of the problems raised by the rational construction of electric accumulators. The new chemical theory has also given me the means of calculating the augmentation of the bulk of the electrodes by *formation* and by discharge, phenomena which I have designated by the name of *increases.*

The study of increases finds, in turn, its practical application in the manufacture of folded accumulator-plates. These expansions, which were formerly injurious, will in future improve and accelerate the formation of the plates.

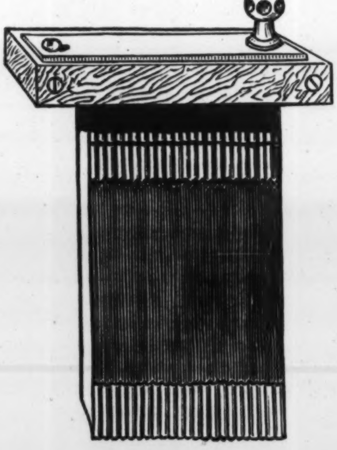


FIG. 1.

My old folded accumulators, fig 1, if the formation was carried too far, took a fan-shaped development, fig. 2, which was clumsy and inconvenient; meantime, the electro-chemical capacity of the accumulator was far from increasing in proportion to the quantities of increased matter; a proof that these substances took little part in the reactions of the discharge.

I thought that by limiting the lateral expansion, I should produce an energetic compression of the superficial dust against the inner sides of the folds, and that these substances, thus compressed against their conductive support, would enter better into activity. I obtained, in fact, more limited expansions and higher electro-chemical capacities by connecting to each other the folds of the electrodes by means of transverse autogenous solderings. But the resistance of the accumulator increased because the liquid had difficulty in penetrating to the interior of these deep and compressed folds. The autogenous solderings were also difficult and costly.

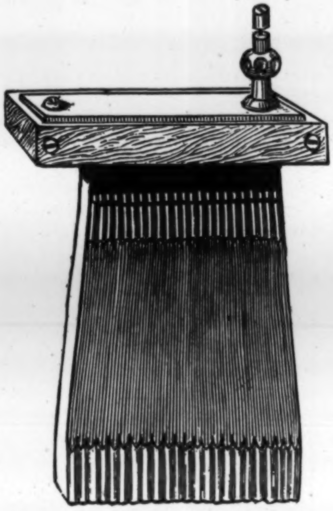


FIG. 2.

These difficulties disappear in the new electrode, with a cast frame, fig 3.

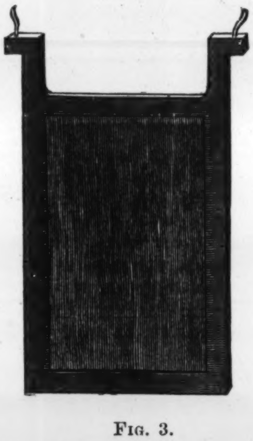


FIG. 3.

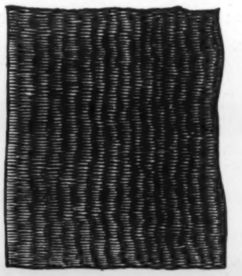


FIG. 4.

The active portion of this electrode consists of a band of rolled lead of 0·95 metre long, 0·16 metre wide, and ½ millimetre thick. This band is then *striated* by passing between the rollers of a special laminator, which imprints upon it shallow marks at little distances from each other, fig. 4; it is then perforated by some sloping slits, and then folded mechanically.

The folded plate, thus obtained, is introduced into a cast-iron mould, which leaves a suitable empty space around it. Melted lead is poured into the mould, so as to form the frame and solder it on all sides to the structure which it surrounds. External prolongations of cast-iron serving as a conductor and a support to the electrode, come in contact with the frame, and form one body with it.

The cast frame is thus a physical and mechanical connection for all parts of the electrode, more solid than the ribs of the old plates. It resists the transverse expansion, and effects an energetic compression of the superficial pulverulent materials which are thus brought into close and extended contact with the conductive portions of the plate.

The following are some numerical data of the new pattern electrode :—

| | | |
|---|---|---|
| Width of plate ... ... | 130 | millimetres. |
| Total height ... ... ... | 245 | " |
| Thickness ... ... ... | 5 | " |
| Weight of folded part ... | 900 | grammes. |
| Total weight ... ... ... | 1500 | " |
| Outer surface of electrode ... | 5 | square decimetres. |
| Total developed surface ... | 45 | " " |
| Total effective surface ... | 35 | " " |
| Corresponding electro-chemical capacity ... ... | 72000 | coulombs. |

We see that the weight of the active portion seems to be three-fifths of the total weight; in reality, the fraction is greater, because the material of the frame is far from being completely inert. I could make a frame lighter by one-half, but I prefer to exaggerate the solidity of the system.

The electro-chemical capacity depends, naturally, on the degree of formation; the figure given is not a maximum.

The formation is effected by the procedures of M. Gaston Planté. It is very rapid, especially if we previously attack the folds with nitric acid, according to the indications of this eminent physicist. The structure of the new plate enables the operation to be pushed very rapidly, as we have not to fear the fall of superficial matter, which is retained very energetically between the wrinkled surfaces by compression.

The mutual distance of the folds is regulated in such a manner that the mean density of the active portion is equal to 8. The density of compact metallic lead being 11·4, the folds leave at first a certain play-room between them; but the formation fills up the empty spaces, and cements the laminæ together. Thus the plate acquires a solidity which speaks well for its lasting power.

The 160 folds distributed over the width of the plate give it, however, in the transverse direction a sufficient elasticity to facilitate the very slight alternate movements of expansion and contraction required by the increase on charging and discharging.

The cast frame secures the mechanical solidity of the entire structure, so that the attackable surface of the active portion may be much increased by employing very slender sheet-lead. But the metal undergoes very high plus values when its thickness gets below ½ millimetre. I have, therefore, stopped at this thickness for electrodes commonly made.

If it is desired, for special reasons, to increase very greatly the attackable surface of the active lead, we may with economy have recourse to another system of plates, which I will describe in an early number.

## ENGINEERING SCHOOLS AND PRACTICE.

"THE technical school, if it would be successful in the graduation of engineers fairly well equipped to enter practical life and work, should have as much contact as possible with the outside world about it," is the *dictum* of the *American Engineer*, which continues :—

"In this it differs from all classical and purely scientific schools. Classics and pure science can be quite as well assimilated, and their best interests furthered as adequately and conspicuously, if the student and devotee remain within the college halls, as if he become acquainted with the busy doings without. Not so engineering or any other profession of applied science.

"The fundamental proposition here stated, relative to technical schools, seems so axiomatic, that it needs little exemplification, and will probably be accepted at sight. But the best means of enabling the student to gain this necessary contact with outside practice, while he is still in the pursuit of his regular college curriculum, is a matter not quite so simple.

"Still, a few measures which will contribute to this end, seem worthy of suggestion and discussion. In the first place, it is essential that the incumbent of the chair of engineering, while being a thorough theorist, versed especially in the mechanics of engineering, so that he can teach the laws underlying the action and design of machinery, should fully realise the importance of verifying the class-room work by the best practice of the day. If he has an adequate sense of this need he will see that the students visit important works of construction, he will have them analyse the working designs of the best engineers, and note the differences between the practical designs and those which the science or theory of applied mechanics would dictate.

"Thus practical points which affect construction will be discovered, and the causes of deviation from theoretical designs defined and appreciated. No amount of workshop exercise within the college—however complete the equipments of the shop—can take the place of this class of work. The workshop is a necessity to acquaint the student with the possibilities of construction, and the methods of doing work; the mechanical laboratory enables him to test the efficiency and strength of machinery and its parts; but only a close inspection and analysis of actual engineering work, and a comparison with the theoretical, will enable him to become acquainted with the modifying influences of experience, finance and adaptation; and only after such knowledge is possessed by him and its importance impressed upon the student, will he take into account these modifying influences in new designs he himself may undertake.

"While pursuing the course of a technical school, especially where the school is in the neighbourhood of large manufacturing centres, a great amount of this work, which will come in, in a measure, as a recreation from the book study and confinement within the college doors, can be done under the direction of the professor of engineering, so much in fact that the newly graduated engineers can have assimilated quite a mass of experience. We believe one afternoon each week in the junior and senior years should be devoted to this class of inspection work, which, in truth, amounts to much more than mere inspection when the designs are analysed under the direction of the head of the department.

"Secondly, we favour fortnightly or monthly lectures by practicing engineers, well known specialists, who would detail elements of design and practice in which they excel. The topics of the lectures should be so selected as to fit in with the regular class-room work and supplement it. Not only would the students thus receive the best thought and experience in condensed form, of able men in the profession, not directly connected with the school; but they would derive all the benefit and all the stimulating influence of a personal contact and acquaintance with leaders of the profession, whose names and works have for some time been known to them. On the other hand, the profession would become more interested in the students, and in the furtherance of technical education.

"In the drawing classes of most technical schools too much attention is still paid to fine finish at the expense often of leaving little time for practice in general plans and details. The engineer in practice merely finishes the drawings finely, spends little time in shading and stippling; while to the laying out, planning and arrangement of the parts he concentrates his best efforts. So we maintain, that while the engineering student should be taught something of the art of finish, the main instruction and practice should be in the direction of accuracy, and of quick arrangement of plans, parts and details. There should be much sketching and projecting work on paper, the details should be worked out, but the artistic part of the drawing should be a minor matter.

"We are aware that in our leading technical schools there is a strong tendency in the direction of the practical points here detailed, but there is, on the whole, still considerable room for organisation in these particulars; while, secondary or minor technical schools have scarcely as yet begun to institute work of this description."

## THE BRITISH ASSOCIATION.

(*Specially Reported for the "Electrical Review."*)

### ON THE STRUCTURE OF MECHANICAL MODELS ILLUSTRATING SOME PROPERTIES OF THE ÆTHER.

By Prof. GEORGE FRANCIS FITZGERALD, F.R.S.

(*Section A.—Mathematical and Physical Science, Sept. 15th,* 1885.)

THE elements of which the model is constructed consist of pairs of wheels so geared together that when one of them rotates it causes the second to rotate in the same direction. The simplest way of effecting this is to connect them by a band, and this is sufficient for a one-dimensional model. Such a model may be constructed by fixing a number of wheels with their axes parallel and at right angles to a plane, and connecting each wheel with its neighbours by elastic bands. This represents a nonconducting region of the æther. A perfectly conducting region is one in which there are no bands, and a partially conducting region would be represented by the bands slipping more or less. A short description of how electrostatic, electrokinetic, and luminiferous phenomena are illustrated by such a one-dimensional model will be clearer than the corresponding description of the tridimensional model, the structure of which is the special purpose of this paper.

As an illustration of an electrostatic phenomenon, consider two conducting regions separated by a nonconducting region everywhere except along one line where the bands are removed. If anywhere in this line a rotation in opposite directions be communicated to the wheels that abut on it, then all the wheels in the nonconducting region will be turned more or less. If anywhere two neighbouring wheels turn equally, there is no straining of the band connecting them; but if one turn more than the other, the connecting band is strained and one side becomes tight and the other loose. Now it will be found in the case considered that all the bands are strained, and that all the tight sides are turned towards one conductor and all the loose sides towards the other. This represents the charging of the two conductors in opposite ways. The strain of the bands in any element of the medium represents the polarisation of the element, and the line joining the tight and loose sides is the direction of polarisation or of electric displacement. The energy of the system is in the form of this straining of the bands, which produces stresses tending to restore the unstrained condition. With a given strain at their respective surfaces, there would be more elements involved and more energy in the medium when the conductors are far apart than when near, showing that if we could represent in any way the fact that conductors can move through the æther there would be forces tending to produce this motion, or, in other words, there would be attraction between these oppositely electrified bodies. As, however, the model does not illustrate the connection between matter and æther, neither this nor magnetic attractions are represented, nor have electromotive forces such as exist in cells been represented. If the forces that have been supposed to turn the wheels along the conducting line connecting the two conducting regions cease to act, the state of strain will disappear, and what represents an electric discharge along this line will take place. All along this line, during the discharge, the wheels at opposite sides will be rotating in opposite directions; so that this is what represents an electric current at any point. It is the same as an electric displacement; and in a nonconductor such opposite rotation is resisted by the stresses in the band, but in a conductor it may take place to any extent. During the discharge the whole of the nonconducting region is full of rotating wheels, and their axes of rotation are at right angles to the direction of discharge. Their velocity of rotation evidently represents the magnetic force accompanying the discharge, and the momentum of the wheels represents the electrokinetic momentum of the current, *i.e.* its self-induction. This is further illustrated by this, that if the frictional resistance be small enough, this momentum will carry the wheels beyond their positions of equilibrium, and there will result an oscillating discharge, such as occurs when an electric condenser is discharged through a sufficiently small resistance. If we suppose a certain amount of frictional resistance at any point along the line of discharge, we may see that the energy expended on friction is conveyed to the place by the bands in the surrounding nonconductor and comes in at the side of the conductor, in accordance with Prof. Poynting's theorem as to the direction of the flow of energy in an electrodynamic system.

The mutual induction of two circuits may also be illustrated by the model. Sufficient has been explained, however, to show how electrostatic and electrokinetic phenomena are represented on the model If a sudden movement of rotation be communicated to any set of wheels, it is evident that inertia will prevent their neighbours being instantaneously turned, while the connecting bands will be strained. Rotation will, however, be communicated to the neighbouring wheels, and from them to their neighbours, by a process which is a species of wave-propagation. If we consider the nature of the disturbance which is thus propagated, we see that it consists in a rotation whose axis is at right angles to the direction of propagation, and of a polarisation of the bands which is at right angles both to the axis of rotation and to the direction of wave-propagation. These are respectively a magnetic and an electric displacement, which are at right angles to one another and to the direction of wave-propagation. This is exactly in accordance with Maxwell's electromagnetic theory of light-propagation. It is thus seen how the same model that can represent electrostatic and electromagnetic phenomena also illustrates luminiferous phenomena by its small oscillations.

If we try to produce a tridimensional model by means of wheels geared together by bands, we are met by the following difficulty. The energy of the model we have been considering may be represented in the following way:—Let $\zeta$ represent the angular rotation of any wheel from a given position; then the kinetic energy of an element will evidently be proportional to $\dot{\zeta}^2$, while the potential energy of an element, depending as it does on the difference of rotation of neighbouring wheels, will be proportional to $\left(\frac{d\zeta}{dx}\right)^2 + \left(\frac{d\zeta}{dy}\right)^2$. If we were to build up a tridimensional model by simply putting together three such systems of wheels in three rectangular planes, the kinetic energy of an element of the model would be proportional to

$$\xi^2 + \eta^2 + \zeta^2,$$

but its potential energy would be simply

$$\left.\overline{\frac{d\zeta}{dx}}\right|^2 + \left.\overline{\frac{d\zeta}{dy}}\right|^2 + \left.\overline{\frac{d\eta}{dz}}\right|^2 + \left.\overline{\frac{d\eta}{dx}}\right|^2 + \left.\overline{\frac{d\xi}{dy}}\right|^2 + \left.\overline{\frac{d\xi}{dz}}\right|^2,$$

instead of

$$\left(\frac{d\zeta}{dy} - \frac{d\eta}{dz}\right)^2 + \left(\frac{d\xi}{dz} - \frac{d\zeta}{dx}\right)^2 + \left(\frac{d\eta}{dx} - \frac{d\xi}{dy}\right)^2,$$

which is what it should be if it is to represent the æther.

The electrostatic and electrokinetic energies of an element of the æther may be expressed in this form by assuming $\xi$, $\eta$, and $\zeta$ to be such that their velocities $\dot{\xi}$, $\dot{\eta}$, and $\dot{\zeta}$ are $\alpha$, $\beta$, and $\gamma$, the components of the magnetic force at the element. Now simple band-gearing will not enable us to arrange that no straining shall result, when, for instance, $\frac{d\eta}{dx} = \frac{d\xi}{dy}$, but this may be accomplished by the following arrangement:—Each element of the æther is to be represented by a cube, on each edge of which there is a paddle-wheel. Thus on any face of the cube there will be four paddle-wheels. Now, if any opposite pair of paddle-wheels on a face rotate by different amounts, they will tend to pump any liquid in which the whole element is immersed into or out of the cube, and if the sides of the cube be elastic there will be a stress which will tend to stop this differential rotation of the wheels. If, however, the other pair also rotate by different amounts they may undo what the first pair do; and thus the stress will depend on the difference between the differential rotations of these opposite pairs of wheels, *i.e.* on $\frac{d\eta}{dx} - \frac{d\xi}{dy}$.

In order that these four wheels may not similarly work with any other wheel in the cube it is necessary to place diaphragms, cutting the cube into six cells, each a pyramid standing on a face of the cube. These must be so made that liquid may not be able to pass from one cell to another through the diaphragm, nor beside the paddle-wheels. In order actually to effect this, the floats on the paddle-wheels would have to be drawn down while passing the diaphragm (of course these mechanical details could hardly be carried out so as to work with sufficiently little friction for the working of any actual model to approximate sufficiently closely to that of the æther for it to be worth while attempting to construct it). The faces of the cube should be filled up with diaphragms past which the paddle wheels should pump liquid, and whose elasticity should be the means of storing electrostatic energy in the medium. It may be worth while pointing out some of the results of having shown that the energy of a disturbance of this medium would be represented by the same equations as those Maxwell has shown to hold for the æther. The most complicated results follow from supposing the faces of the cubes, of which the medium is constructed, to have different elasticities. Such a structure represents a crystalline medium. Its vibrations would be propagated according to the laws of propagation of light in crystalline media. The wave surface would be Fresnel's wave surface, and it would exhibit conical refraction. If the cubes were twisted, the structure would be like that of quartz or other substances that rotate the plane of polarisation of light. In order to represent the rotation of the plane of polarisation of light by magnetism, it would be necessary to introduce some mechanism connecting this æther with matter. That this would be required is evident from the consideration that no amount of inherent rotation of these wheels would alter the plane of polarisation of a vibration transmitted by them. Now, although I am not prepared to suggest any actual method of connection, it may be worth while pointing out two different ways in which it may work. In the first place the matter may be in rotation when subject to magnetic force;

and it may be connected with the æther in such a way that the direction of its axis and rotation is altered by the vibrations passing in the æther. It would then react on the æther in such a way as to rotate the plane of polarisation of the wave. In the second place the matter might only act as a link connecting æther elements rotating in rectangular directions in such a way that the rotation of one element altered the axis of rotation of a rectangular element. The reaction of this latter on the former would then rotate the plane of polarisation of a wave propagated parallel to the latter. The first of these connections is that in accordance with Maxwell's theory as to the connection between the æther and matter that he introduces in his "Electricity and Magnetism," in order to explain the rotation of the plane of polarisation of light by magnetism; while the second is the one that I supposed in my paper "On the Electromagnetic Theory of the Reflection and Refraction of Light" (R. S. Trans. 1880).

I need hardly say, in conclusion, that I do not in the least intend to convey the impression that the actual structure of the æther is a bit like what I have described. What physicists ought to look for is such a mode of motion in space as will confer upon it the properties required in order that it may exhibit electromagnetic phenomena. Such a mode of motion would be a real explanation of these phenomena. I have only given a description of them.

I think, however, that it is worth while considering these models, because in them the disturbance which represents light is not the same as the vibrations of an elastic jelly, for what represents an electric displacement is a change of structure of an element, and not a displacement of the element; and it seems almost certain that, notwithstanding the very high authority which seems to support the view that the æther is *like* an elastic jelly, nevertheless its vibrations are much more of the nature of alterations in structure than of displacements.

### DISCUSSION.

Prof. **POYNTING** said there appeared to him to be some reason for supposing that the magnetic action in the neighbourhood of a current-bearing wire was due to the energy in the wire, and not to anything spreading out from the wire. He would like to know whether the model bore out the view that the magnetic intensity in the neighbourhood of a wire was an accompaniment of the transmission of energy by the wire.

Prof. **FITZGERALD** replied that in a perfect conducting region there would be no transmission of energy by the wire in his model. The magnetic force round the wire was represented by the rotation of the wheels, while the energy was being transmitted by the India rubber bands, and the transmission of energy into the wire was intimately connected with the fall of potential in the wire. It was that fall of potential which was represented by the straining of the bands.

Prof. **POYNTING** asked, in a case where there was a perfect conductor, and there was energy transmitted and electrical strain in the conductor, as that dissipated, would there then be any magnetic action? Suppose they had two plates of a charged condenser, the strain in which was giving way, would there be any magnetic action then? Would the wheels rotate between the two plates?

Prof. **FITZGERALD** replied that he believed they would, but it was difficult to give a positive answer. Anything in the nature of an electric current was in his model accompanied by a rotation of the wheels; that was by magnetic force, whether it was a current of conduction in the wire or a displacement in the position of the conductor.

Prof. **MINCHIN** thought, to summarise Prof. Fitzgerald's remarks, he removed Maxwell's difficulty with regard to æther by stating that the actions between the components of stress and strain were in linear relation. He would ask Prof. Fitzgerald whether they might discard the belief that Maxwell intended to convey the idea that there was no such relation.

Prof. **FITZGERALD** disclaimed having put any interpretation upon Maxwell's opinion which Maxwell did not intend, and referred to a paragraph in "Electricity and Magnetism" in which Maxwell said: "There is one part of my period which I have not attempted to bridge over, and that is, the reasons for the connection between the electric displacement and the mechanical stress." He stated over and over again that he had not formed any theory as to the nature of electric displacement, nor as to the connection between it and the mechanical stress. He (Prof. Fitzgerald) was quite sure he did not intend what he called electric displacement to be the displacement of the æther. The only thing which it could possibly be was some sort of destruction of the ether.

Lord **RAYLEIGH** said he obtained the same impression of Maxwell's meaning as Prof. Fitzgerald.

Mr. **GLAZEBROOK** agreed with Prof. Fitzgerald and Lord Rayleigh as to the fact that Maxwell did not intend the displacement of the æther. This was too often the interpretation put upon his writings, but he was quite convinced that it was entirely contrary to what Maxwell intended. Prof. Fitzgerald's model reminded him of a model which Maxwell himself devised, which consisted of wheels very similar, only that they were connected together by cogs and a series of loose wheels lying between. The rotation of one set of wheels represented the magnetic rotations, and the other the electric displacements.

The **PRESIDENT** said he happened to know as a fact that at a late period of his life Maxwell had no definite ideas as to electric displacements.

## COMBINED RESISTANCES.

*On a Method of Finding the Resistance of the Wheatstone Bridge without the assistance of the currents in their respective branches.*

By THOMAS PAUL, Foreman, Indian Government Telegraph Works, Alipore, Calcutta.

LET the current flow as indicated by the arrows in fig. 1, then as the point, P, is at a higher potential than the point, Q, there must be a point between M and Q having the same potential as the point P. Let that point be denoted by $P^1$, the joining of which to the point, P, will cause no variation of resistance between the points M and N. Again, as the point, Q, is at a lower potential than the point, P, there must be a point between P and N having the same potential as the point Q. Let that point be denoted by $Q^1$, the joining of which to the point, Q, will likewise cause no variation of resistance between the points M and N.

FIG. 1.

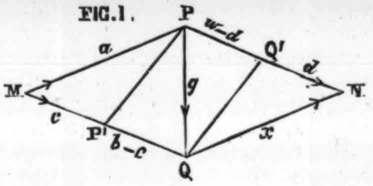


FIG. 2.

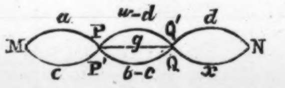


FIG. 3.

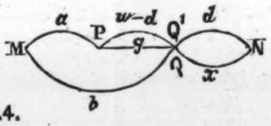
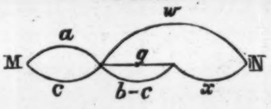


FIG. 4.



When the above conditions are established the bridge may be drawn as in figs. 2, 3 and 4, and no difficulty will then be experienced in finding the unknown branches.

From figs. 2 and 3 we have

$$\frac{b\left\{a + \dfrac{g\,(w-d)}{g+w-d}\right\}}{a + b + \dfrac{g\,(w-d)}{g+w-d}} =$$

$$\frac{a\,c}{a+c} + \frac{g\,(w-d)\,(b-c)}{g\,(w-d) + g\,(b-c) + (w-d)\,(b-c)}$$

from which

$$c = \frac{a\,b\,(g+w-d)}{a\,g + (a+g)\,(w-d)}\,.$$

From figs. 2 and 4 we have

$$\frac{w\left\{x + \dfrac{g\,(b-c)}{g+b-c}\right\}}{w + x + \dfrac{g\,(b-c)}{g+b-c}} =$$

$$\frac{d\,x}{d+x} + \frac{g\,(w-d)\,(b-c)}{g\,(w-d) + g\,(b-c) + (w-d)\,(b-c)}$$

from which

$$c = \frac{w\,x\,(b+g) - b\,d\,(g+x) - d\,g\,x}{w\,x - d\,(g+x)}$$

therefore

$$\frac{a\,b\,(g+w-d)}{a\,g + (a+g)\,(w-d)} =$$

$$\frac{w\,x\,(b+g) - b\,d\,(g-x) - d\,g\,x}{w\,x - d\,(g+x)}$$

from which

$$d = \frac{w\,x\,(a + b + g) + a\,g\,x}{x\,(a + b + g) + b\,g}$$

or

$$\frac{w\,x\,(a + b + g) + b\,g\,w}{x\,(a + b + g) + b\,g}$$

Now, substituting this value of $d$, all the quantities of which are known, in the formula derived from fig. 3, which is the resistance of the bridge, we get,

$$\frac{g\,(a + w)\,(b + x) + a\,w\,(b + x) + b\,x\,(a + w)}{g\,(a + b + w + x) + (a + b)\,(w + x)}$$

or

$$\frac{a\,b}{a + b} + \frac{w\,x}{w + x}$$

[A solution of this problem of a somewhat similar nature to the foregoing will be found in the number of the REVIEW for May 1st, 1875.—EDS. ELEC. REV.].

## LONG DISTANCE TELEPHONY.

AT the recent annual meeting of the National Telephone Exchange Association in America, a paper on "Some Practical Results of Long Distance Telephoning," by Mr. A. S. Hibbard, of the Wisconsin Telephone Company, was read by Mr. W. D. Sargent. The paper gave an interesting statement of the results obtained by prominent companies in America and abroad. Mr. Hibbard stated that in 1877 the first successful long line results were obtained in experimental tests over telegraph lines. In 1874 many short telegraph lines were equipped with telephones as private lines, and as such were used between stations five to fifty miles apart. In 1878 and 1879, the extension of extra territorial lines, or toll lines, was begun, and the "bean pole" and "barn top" lines were constructed, retarding in some instances the development of successful long line systems. To-day, the well-known results of six years' work are exhibited in a showing of 1,252 exchanges, 134,847 subscribers, 539,388 exchange connections daily; 25,766 miles of poles in toll line, 35,631 miles of wire; 18,330 toll connections daily. Mr. Hibbard then gave figures based upon the statements given by several prominent companies, with exchange lines. The rates were generally uniform, the minimum being 25 cents. and maximum 50 cents. for use of a wire five minutes or less. The paper considered the toll ticket plan as profitable, and then devoted considerable space to the matter of interrupting noises. The introduction of resistance into the circuit has been found beneficial in suppressing inductive disturbances, but has in a corresponding degree weakened the telephonic effect. Leaky lines have been found less noisy than those well insulated. The most natural and general remedies are a louder transmitter and a less sensitive receiver. It has been proven beyond dispute that the best wire for long lines is that of the smallest diameter and of the lowest resistance. The hard drawn copper wire was perfected and introduced largely, and the best results in long distance telephoning have been obtained over this wire. In conclusion, the essayist stated that the inventive genius of the world is straining every nerve to produce the "far speaker," and no such pressure was ever before brought to bear on any one department of business. For the solution of this problem the public looks to the American Bell Telephone Company and its licensees in the United States. It was with much confidence that he ventured the opinion that the expectation will be satisfactorily and speedily realised. The Chicago company has a main line of 62 miles, and entire plant of 348 miles; the Wisconsin company has a main line plant of 110 miles, and entire plant of 335 miles; the Michigan company has a main line of 100 miles, and entire line of 190 miles; the Bell Telephone Company has a main line of 85 miles, from Buffalo to Rochester. The limit of distance in practical and profitable working is about 100 miles, although a considerable business is done over 150 to 200 miles of wire.

In the discussion which ensued, and in response to inquiries as to the present limit of long distance telephony, Mr. Cowles, of Buffalo, stated that there was a line of 90 miles between Rochester and Buffalo, over which, at certain times during the day, conversation could be carried on fairly well. At that distance, however, such work does not constitute a good commercial line. They have no lines over 50 or 60 miles in length, that being about the limit of practical work.

Mr. Sise, of Montreal, said that his company had a main line 800 miles in length, and were working about 3,000 miles of trunk lines. They used No. 9 wire. They worked distances of 150 to 200 miles, the wires not being insulated.

Mr. Uline, of Albany, said that a copper wire from that city to Newburg, 100 miles, was perfectly satisfactory, the wire passing through two switchboards.

Mr. J. J. Fowler, of New Orleans, said the Great Southern company had a circuit of 138 miles, No. 14 copper, which was worked through two intervening exchanges, also 115 miles of No. 14 steel wires as feeders. There was also a line of 120 miles of No. 10 wire, working through three cables.

Mr. Sise did not think the cost of maintenance was of so much importance as that of accounts. At present about 25 cents. worth of book-keeping was required for each 25 cent. message.

Mr. Fowler had thought it possible that the large expanse of water in his territory under the lines might have a beneficial effect upon their working.

Mr. McCluer, of Richmond, entertained a similar belief. They have a line to Point Pleasant which works well, while another between Richmond and Petersburg can scarcely be used on account of the disturbances arising from induction. The former line runs along the James river, while the other goes across country. Without presenting any theory, he suggested that veins of metalliferous deposits, or bodies of water running parallel with the wires, might furnish a channel for extraneous currents, thus relieving the wires from such influence.

Mr. Lockwood said that for the benefit of the association he was compiling a list of all the remedies which had been proposed for eradicating induction, which he hoped to present at some future meeting.

Col. Keller, of Boston, stated that their limit of long line work was practically 40 to 50 miles, although they had occasionally talked with Portland, a distance of 110 miles.

Mr. Sargent stated that no difficulty was experienced in working a copper wire between Jersey City and Trenton, 65 miles, but there was difficulty in working through the North river cable to New York, and consequently the wire was of no practical use, as there was but little business between Trenton and Jersey City.

## AN ELECTRICAL FURNACE FOR REDUCING REFRACTORY ORES.

THE following is an abstract of a paper read by Prof. T. Sterry Hunt, on "An Electrical Furnace for Reducing Refractory Ores," at the recent meeting in Halifax, Nova Scotia:—

"The power of electric currents to generate intense heat in their passage through resisting metals has long been known, and the late Sir W. Siemens thereby succeeded in melting considerable quantities of steel. It was, however, reserved to Messrs. Eugene H. Cowles and Alfred Cowles, of Cleveland, O., to take a new step in the metallurgic art by making the heat thus produced a means of reducing, in the presence of carbon, the oxides, not only of the alkaline metals, but of magnesium, manganese, aluminum, and silicon, with an ease which permits the production of these elements and their alloys with copper and other metals on a commercial scale. In the apparatus devised and now employed by Messrs. Cowles, a column of fragments of well calcined charcoal, so prepared and arranged as to present the requisite electrical resistance, is imbedded horizontally in finely-pulverised charcoal, and covered by a layer of the same material coarsely broken, the whole being placed in a box of fire brick covered with perforated tiles and opened at the ends to admit two carbon electrodes an inch-and-a-half in diameter. Through these the current from a dynamo-electric machine of twenty horse-power is now made to traverse the central core of carbon, whereby such a temperature is at once produced that platinum or iridium may be instantly melted therein, and the most refractory oxides already named are not only fused and volatilised, but reduced to their elemental state with formations of carbonic oxide gas. If allumina, in the form of granulated corundum, is mingled with the carbon in the electric path, aluminum is rapidly liberated, being in part carried off with the escaping gas, and in part condensed in the upper layer of charcoal. In this way are obtained considerable masses of nearly pure fused aluminum and others of a crystalline compound of the metal with carbon. When, however, a portion of granulated copper is placed with the corundum, an alloy of the two metals is obtained, which is probably formed in the overlying stratum, but at the close of the operation is found in fused masses below. In this way there is got, after the current has passed for an hour-and-a-half through the furnace, from four to five pounds of an alloy containing from 15 to 20 per cent. of aluminum and free from iron. On substituting this alloy for copper in a second operation a compound with over 30 per cent. is obtained. Already the small experimental plant with a 30 horse-power dynamo is producing daily over five pounds of aluminum in the form of a rich and brittle alloy, which, by suitable additions of copper, is converted into different grades of aluminum bronze. The remarkable qualities of these are so well known that it is only their great cost hitherto which has prevented their more general use in the arts.

"They are now offered for sale at Cleveland on a basis of $5 a pound for the contained aluminum. When silicious sand mixed with carbon is placed in the path of the electric current, a part of it is fused into a clear glass and a part reduced with the production of considerable masses of crystallised silicon, a portion of this being volatilised and reconverted to silica. By the addition of granulated copper there is readily formed a hard, brittle alloy, holding 6 or 7 per cent. of silicon, from which silicon bronzes are cheaply made. The direct addition of clay gives an alloy, of silicon and aluminum, and with copper silico-aluminum bronze, which appears to possess properties not less valuable than the compounds already mentioned. Even boric oxide is rapidly reduced, with evolution of copious brown fumes of boron and the formation, in presence of copper, of a boron-bronze, which promises to be of value, while under certain conditions crystals of what appears to be the so-called adamantoid boron are formed. In some cases, also, crystalline graphite has been produced, apparently through the solvent action of aluminum on carbon.

"Remarkable results are got by alloying small quantities of aluminum with an admixture of copper and nickel. One of these compounds broke with a strain of 111,000 pounds to the square inch, with an elongation of 35-100, while a 10 per cent. aluminum bronze broke with 109,000 pounds. An addition of from 2 to 5 per cent. of aluminum to the brass greatly increases its tensile strength and renders it less liable to oxidation. While 15 or 20 per cent. of aluminum with copper yields a brittle compound, an addition of 10 or 15 per cent. of copper gives to pure aluminum a great increase of hardness and tenacity, forming an alloy which may have a wide application. It may be added that the difficulties in gathering together the reduced aluminum without the aid of copper promises to be overcome at an early day, so that we may expect the cheaper production of such alloys and of pure aluminum.

"The Messrs. Cowles, in their later work, have been aided by the chemical skill of Prof. C. F. Mabery, now of Cleveland, who is associated with them in their patents. These now cover not only the reduction of aluminum, silicon, and boron, as above described, but the extraction of manganese, magnesium, and the alkaline metals by the electric furnace. I had the pleasure of hearing Prof. Mabery give the first scientific notice of this discovery before the American Association for the Advancement of Science at Ann Arbor, August 28th, and I then spoke of the early results of H. de Ville and those of De Bray, on alumina and its alloys, having myself witnessed many of the experiments of both these chemists thereon. I also insisted that the importance of this new instrument, which the Messrs. Cowles have placed in the hands of chemists for producing and controlling degrees of temperature never before attained, can scarcely yet be estimated, either in its economic or scientific aspect. The heat of this furnace realises the dream of the alkahest or universal solvent of the alchemists, and he who can rightly use it will merit the ancient title of *magister magnis in ignis*. I then suggested trials for the reduction of titanium, both from rutile and from titanic iron ore, which will probably soon be made. I may add that, through the courtesy of these gentlemen, I have since been enabled to spend two entire days in their experimental works at Cleveland with the brothers Cowles and Prof. Mabery, when they explained to me several points not yet finished, and allowed me to direct experiments with one of their furnaces.

"The fusion of quartz and the reduction of silicon without the presence of copper, the reduction of boron with the formation of boron-bronze, and other remarkable experiments, were then tried. The present plant is but a first experimental one, and has only been in operation a few months. The Cowles Electric Smelting Company have secured a large water power at Lockport, N.Y., and a dynamo-electric machine of 125 horse-power is now building for their use at the Brush works in Cleveland, which will soon be in operation at Lockport, and will permit of the establishment of the electric furnace on a large scale. A series of specimens of the products thus far got by their remarkable discovery is, through the courtesy of the inventors, now laid before the members of the Institute of Mining Engineers."

## UNDERGROUND WIRES.

AT the American Telephone Convention in September a paper was read by Mr. W. R. Patterson, of the Western Electric Company, on "The Underground Problem." The paper was in substance as follows :—

There are two classes who do not admit the existence of the "underground problem," namely, the enthusiastic inventors and promoters of "systems," and the average state and city legislator. The two form a mutual admiration society of gentlemen of vast scientific attainments and disinterested philanthropists. One of the former will admit that it used to be a problem over which electricians had laboured in vain; the subject was accidentally brought to his attention by a newspaper report of the delay to the firemen caused by a lot of wires. It immediately occurred to him that those wires might be put underground. He lays no claim to any electrical knowledge, but is only a man of marked practical common sense, unhampered by any scientific hair-spliting. Governed only by the practical common sense requirements of the case, he devoted several hours to thinking on the subject, and the problem was solved. Not satisfied with its general solution, he subsequently went through a long course of mental experiment, thoroughly reduced it to paper, and had it patented. It now only awaits your adoption. The promotor of the Universal Electric, Signal, Telegraph, Telephone, Electric Light and Power Transmission, Underground Insulated Cable, and Conduit Construction Company, knows the system can only be an unqualified success. Isn't it patented? If that isn't enough, didn't the attorney tell the inventor that an examiner in the office overheard the commissioner say to the secretary of the interior that there wasn't anything in the earth or the heavens above, or the waters under the earth, that in any way resembled this wonderful invention?

Some rainy day when the base ball game is postponed, the leading newspaper sends its scientific reporter to find out all about the subject. The reporter is a young man just out of a college where he has learned all about the recession of Greek accents; he laughs scornfully at the man who asks him how they make those little telephone wires hollow, and the next day furtively picks up a piece to examine, finds it solid, and thinks he may have been mistaken, after all, and got a piece of telegraph wire! This knowledge, backed by a vivid imagination, and all the information obtainable from the inventor, furnishes the basis of a long local article and of an editorial in which is duly set forth the meanness, heartlessness and want of regard for the rights, property and lives of our citizens on the part of these grinding monopolies. The philanthropic legislator is impressed by all these things. He "don't take no stock in them scientific chaps; they are all in the pay of some big monopoly, and everyday hoss sense is good enough for him." He knows of no obstacle, mental, physical or moral, that money will not overcome, and here is a chance to get at these "grinding monopolies," help the struggling inventor, make business good, and get the vote of that man who is kicking about a telegraph pole in front of his house. So an ordinance is passed requiring all the wires to be placed underground within thirty days, and what is the use for us at this late day to talk about an underground problem?

You, gentlemen, have all read the information furnished by such a reporter, have suffered under such a legislator, and been taught your business by such an inventor. It has been demonstrated to you beyond question that your wires will work better and for a longer distance, and that there can never, under any possibility, be any outlay for repairs or reconstruction in this underground system. If you have not already, it is probable that you soon will meet with a sufficiently enthusiastic promotor who will demonstrate mathematically that the junk value of your old wire and insulators, and the kindling wood value of your poles and fixtures, will pay for an entire and absolutely perfect underground system. Yet in spite of all these demonstrations, and in spite of the assumed power of a city council to regulate not only the laws of trade, but the laws of nature, it is a fact that men who are practically interested in the matter still see difficulties in the way.

These difficulties may be divided into three general classes—scientific, mechanical and financial. One man tells us there are no scientific difficulties in the way of underground telephony, and another tells us they are insuperable, and both are right. If it is only a question of talking across the street, there are none; if it is a question of talking across the ocean or a continent, they are insuperable with our present knowledge. It would be very rash to claim they must always be so, but it will take something besides an act of the legislature, or an ordinance of the city council, to overcome them. The scientific obstacles in the way of unlimited and universal underground telegraphy and telephony are retardation, escape and induction. These difficulties are common to underground wires for all uses, but are especially troublesome in telephone work. It is the subject which has received least attention from inventors of systems, and it seems entirely beyond the comprehension of most people that an underground wire, say from the Harlem river to Jersey City or South Brooklyn, may, in some respects, be an exact counterpart of an aerial line from New York to Buffalo or Pittsburg.

The causes of retardation are well understood, and its laws well defined, both by mathematical reasoning and by actual experiments upon long submarine cables. Every text book of electricity gives formulæ for the speed of working cables, and in connection therewith the distance which a cable of any specifications can be worked at a given speed, which is the telephonic way of stating the case. If a telegraph cable will not work at the rate of 40 words per minute, it may be perfectly feasible to work it at a speed of 20, and it is only a question of providing a duplicate cable if the business requires 40 to be sent. But the laws of acoustics fix the number of vibrations per second for any definite sound, so if a cable cannot carry the requisite number, that is an end of the matter. The distance which can be marked is shown to be a function of the resistance of the conductor and its electro-static capacity. In the present state of metallurgical science it is not to be expected that a better conductor than copper can be found. While chemists and others, principally others, can turn out new insulating compounds almost without number, they can all be grouped into a few generic classes, the properties of which are well understood. It is not to be expected that a material of lower inductive capacity than air can be discovered, or an insulator suitable for underground use which even approximates the low capacity of air. We cannot make up the deficiency by increasing the thickness of the insulator indefinitely, because that has comparatively small effect. Besides these theoretical objections there are practical difficulties in handling a large number of wires which necessarily limit the size of each, and finally there is a limit to the last which precludes the use of metal and insulator in unlimited quantities per foot. The other factor, the resistance of a telephonic circuit, has been generally, until of late, considered to be of little importance.

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After the mechanical work connected with the manufacture of the wire and its insulation is properly performed, there still remain mechanical difficulties to be overcome in laying the wires so as to secure the utmost possible durability, or even to insure any service at all. None of these mechanical obstacles are insuperable, or offer as much difficulty as the electrical requirements which we have discussed; yet they are not to be neglected, as any want of forethought or care in handling and protecting the wires may destroy the best electrical work. Most of the mechanical difficulties experienced are of such varying character that only a careful study of the conditions existing in each place can overcome them. In general, the system which requires the least possible work to be performed in the street will escape much of the danger of injury. The number of impossible things that happen and the grand aggregate of all the little things that are done to the detriment of the work by an inquisitive crowd, the weather and the total depravity of inanimate matter, would seem incredible to any one who had not experienced them. What is the best method of protecting underground wires from external injury, is as easy to decide as the best way of protecting human life from loss by accident and violence. The ideal protection for underground wires would be a dry, light, roomy and well ventilated subway. Such a one can be constructed with the utmost facility on paper. It would be found in a city built to order under one comprehensive plan, and before it is lived in completely equipped for 100,000 or 1,000,000 inhabitants, as the case might be, with no subsequent additions allowed. But we have to take cities as we find them, which, like Topsy, "have growed." With the existing systems or more generally lack of systems of sewers, water, steam and gas pipes, street railways, and the general plan of streets and alleys such a subway is impractical. We are reduced to two general methods of protection; one is to lay the wires or cables, and fill in around them with a mass of protecting material, as asphalt or cement; the other is to draw the cables into a previously constructed conduit. Neither method is free from disadvantages when compared with the ideal subway, but the conduit plan seems to have less than the other, and to offer some advantages which are a fair return for the additional expense. In the choice of a method of protection all the local conditions are to be considered, and a plan which is successful in one place may be a failure in another.

The third class of objections we see are financial. It needs no argument to show that it will cost a great deal more to put all the wires of an exchange underground than to carry them on poles and house tops. Saying nothing about its theoretical advantages, air is by far the cheapest insulator known. The insuperable part of the financial difficulty is the proposed throwing away of a full equipment of lines which are in working condition, and replacing them by an entirely new and more expensive system. To even overcome the difficulty due to the difference in cost, the exchange must be made gradually—no faster than the existing lines need renewal.

After all this enunciation of the difficulties in the way of underground service, it may seem that we have left no useful field for it. But there is an extensive field open to such service, and we wish only to look at the matter fairly and impartially, recognising the existence of serious obstacles which cannot be dismissed with a word. We are convinced of the existence of certain limitations which have been enumerated. We are also convinced that within these limitations there are no reasonable doubts of the perfect success of underground service, as far as any electric troubles are concerned; that while no rigid system may suit all places, there are no mechanical difficulties that cannot be solved by attention to the local conditions; and, finally, there are no financial objections which are more far reaching than the others, or which would be serious if the change were made gradually. In the proper municipal supervision of electric wires there seems to be an exact parallel with supervision over buildings. When a city reaches any considerable size, the general welfare demands the establishment of fire limits within which the use of inflammable building material shall be restricted. But it has never gone to the extent of compelling owners of wooden buildings within these limits to tear down their structures and replace them with fire-proof material; neither has it forbidden the use of wood in subordinate parts of the structures, or wooden palings and gates in residence streets. It does not refuse permission to prolong the life of wooden buildings by keeping them painted, or by stopping leaks in the roof or replacing broken glass. When a great number of wires accumulate in a neighbourhood so as to be a nuisance, it is perfectly proper for those who have the welfare of the city in charge to say that the line must not be rebuilt except underground. But what is the difference between ordering the demolition of a line of poles and wires and the demolition of a wooden building because both are liable to endanger adjacent structures in case of fire, and because both are more useful than ornamental?

The idea of putting all the wires in any city underground throughout their whole extent is not worthy any discussion—it is entirely impracticable. But in any large city the number of wires in the neighbourhood of the exchange is a nuisance, both to the public and to the company, and there is no objection, scientific, mechanical or economic, to putting them underground for moderate distances, until they begin to diverge and scatter to reach individual subscribers. In some cases it is absolutely necessary to cable the wires in order to handle them, and there is very little difference in the working of any aerial and underground cables—none at all if they are inclosed in metal. It would be advantageous to use a special conductor for trunk lines and long extra territorial circuits. This is about all that can be done with the present apparatus, and with our present knowledge of the methods of overcoming the difficulties in the way. It is all that has been done in any place, and all that any body of lawmakers can compel to be done successfully. It is doubtful if there is a large exchange in the country that would not voluntarily do as much when the present pole lines need rebuilding. The most conclusive experiments that have been made, and the most extensive work that has been done thus far, have not been under compulsion, but voluntarily. It does not seem that at present we have sufficient data to say absolutely just what length of wire can be worked underground. We are sure that the entire system of any large city cannot be put underground for good scientific and financial reasons. We are sure that the entire system of any small exchange cannot, for financial reasons alone. We are sure that a general and extensive local adoption of underground wires would prevent long distance telephoning, except perhaps from office to office. On the other hand, we are sure that when it is required to handle a large number of wires in a small space for a moderate distance no one need fear any bad results from using underground cables. The only thing we are not sure of is the exact length of a "moderate distance." But it is probable that no trouble would be experienced in any place up to the limit of 100 wire cables—that is, as far from any office as any 100 wires pursue the same route.

In conclusion, to state our creed, we believe in both aerial and underground wires, without bigotry or intolerance towards either, and with due recognition of a suitable and proper field for the use of each. We do not have much faith in the man who says he can put 2,392 wires in a space $2\frac{7}{8} \times 3\frac{1}{4}$ inches; neither do we expect a lineman will be a necessary feature of every circus of the future, to show people how they used to climb poles in the old days of telephone wires.

The paper was received with applause.

The paper of the president, Mr. C. N. Fay, which followed Mr. Patterson's paper, discussed much the same question, and some additional suggestions on the subject were presented for the consideration of the convention. Mr. George F. Durant occupied the chair during its reading. The paper, like its predecessor, was listened to with marked interest, and ordered to be placed on the records.

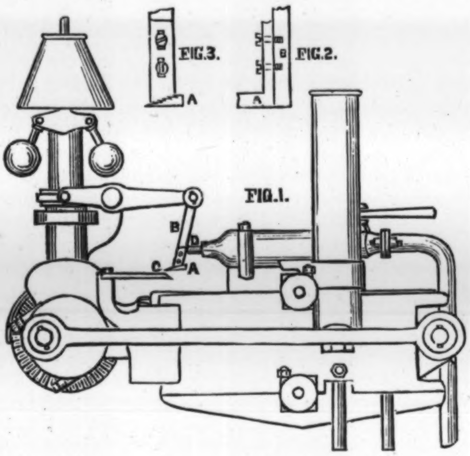
The papers were discussed in common, Mr. Thomas D. Lockwood, of Boston, presenting the report of the select committee of the British House of Commons on the subject, and Mr. W. D. Sargent, of Brooklyn, gave the experience of the companies in that city.

General Thomas Sherwin, auditor of the American Bell Telephone Company, read a paper on "Telephone Accounts," in which he discussed some of the existing methods of keeping the books of the companies, and presented his idea of a practical and efficient scheme. The paper was on the line of the ideas held at headquarters to establish a uniform system of keeping accounts in the various offices, and provoked much discussion and many additional suggestions.

## VOLK'S GAS ENGINE GOVERNOR ATTACHMENT.

THE device illustrated by the accompanying engraving has been made by Mr. Magnus Volk, of Brighton, for governing the 8 horse-power Otto Crossley gas engine which drives the machines for the Brighton Electric Railway, by varying the quantity of gas admitted instead of either admitting the usual charge or cutting it quite out. The engraving is of the end view of the engine, and shows the governor, gear, the igniting slide, and gas valve.

The *Engineer*, from which journal our illustration is taken, states that in the ordinary way the gas valve spindle, D, is pushed in by the projection, C, on the igniting slide, through the medium of the pendent lever, B, when that lever is low enough for the piece, $\text{A}^1$, as shown in the detail, fig. 2, to come into contact with C. Thus the gas is admitted in the same quantity throughout that range of speed which is represented by the rise or fall of the governors through the height of the thickness of $A^1$. Thus the engine gets full gas or no gas, and between these there is a change of speed which, though of no importance for most work, is productive of slight irregularity, which is undesirable in electric work. To overcome this, Mr. Volk has adopted the stepped form of projection shown at figs. 1 and 3. By this means the quantity of gas is regulated through as many gradations as there are steps. Mr. Volk has had it at work several months, and finds that it considerably improves the running of the engine.



## THE EDISON INCANDESCENT SYSTEM.

INCANDESCENT lighting from central stations is making steady progress, as will be learned from the following list of plants established by the Edison Company :—

| Name of City or Town. | State. | Capacity of Machinery. | Lamps Supplied. |
|---|---|---|---|
| Berlin | Germany | 14,000 | ... |
| Milan | Italy | 8,000 | ... |
| New York | New York | 8,000 | 1,300 |
| Bellefonte | Pennsylvania | 800 | 1,200 |
| Middletown | Ohio | 500 | 700 |
| Williamsport | Pennsylvania | 3,200 | 4,500 |
| Piqua | Ohio | 1,000 | 1,200 |
| Newburgh | New York | 2,400 | 3,000 |
| Tiffin | Ohio | 1,000 | 1,200 |
| Fall River | Massachusetts | 2,400 | 3,000 |
| Hazelton | Pennsylvania | 1,000 | 1,200 |
| Lawrence | Massachusetts | 3,200 | 4,500 |
| Shamokin | Pennsylvania | 2,400 | 3,000 |
| Brockton | Massachusetts | 2,400 | 3,000 |
| Circleville | Ohio | 1,050 | 1,200 |
| Cumberland | Maryland | 1,000 | 1,200 |
| Des Moines | Iowa | 1,600 | 2,000 |
| Appleton | Wisconsin | 500 | 2,000 |
| Harrisburg | Pennsylvania | 4,800 | 5,000 |
| Westchester | Pennsylvania | 1,600 | 2,000 |
| Johnstown | Pennsylvania | 1,000 | 1,200 |
| Tamaqua | Pennsylvania | 1,600 | 2,000 |
| McKeesport | Pennsylvania | 1,600 | 2,000 |
| New Brunswick | New Jersey | 1,600 | 2,000 |
| Boone | Iowa | 600 | 1,000 |
| Wilmington | Delaware | 1,600 | 2,000 |
|  |  | 68,850 | 51,400 |

The following classification of isolated plants will be found of special interest, as showing the various lines of business which have found it advisable to adopt private incandescent lighting.

PLANTS ESTABLISHED FOR AND OWNED BY PRIVATE USERS.

|  | Plants. | Lamps. |
|---|---|---|
| Educational institutions, public asylums, and hospitals | 26 | 7,173 |
| Hotels, apartment houses, and club rooms | 23 | 11,035 |
| Theatres and places for amusement | 20 | 14,033 |
| Banks, office buildings, stores, residences, &c. | 73 | 23,757 |
| Newspaper and other printing offices | 30 | 6,521 |
| Sugar refineries | 11 | 4,864 |
| Flour mills and grain elevators | 26 | 1,934 |
| Cotton, woollen, and textile fabric mills | 81 | 25,898 |
| Pulp and paper mills | 30 | 3,318 |
| Oil refineries, distilleries, dye houses, chemical works, and meat-packing houses | 29 | 3,392 |
| Water works, rubber factories, and miscellaneous manufacturing establishments | 39 | 5,088 |
| Iron works, car and machine shops | 40 | 7,828 |
| Furniture and pianoforte manufactories and wood-working establishments | 15 | 2,360 |
| Steamships, steamers, yachts, &c. | 51 | 8,092 |
| Grand totals | 494 | 125,293 |

This makes a grand total of 177,000. Or, if the lamps actually placed in isolated plants were taken instead of merely the dynamo capacity, a grand total of upward of a quarter of a million Edison lamps in actual use in this country alone.

## THE HYDRO-ELECTRIC METER OF MM. MARCHAND AND GERBOZ.

THE apparatus shown in the accompanying figure has been submitted to the Société d'Encouragement, which has recently signified its approval of the favourable conclusions of the report of M. Leroux, who was commissioned to examine the new system.

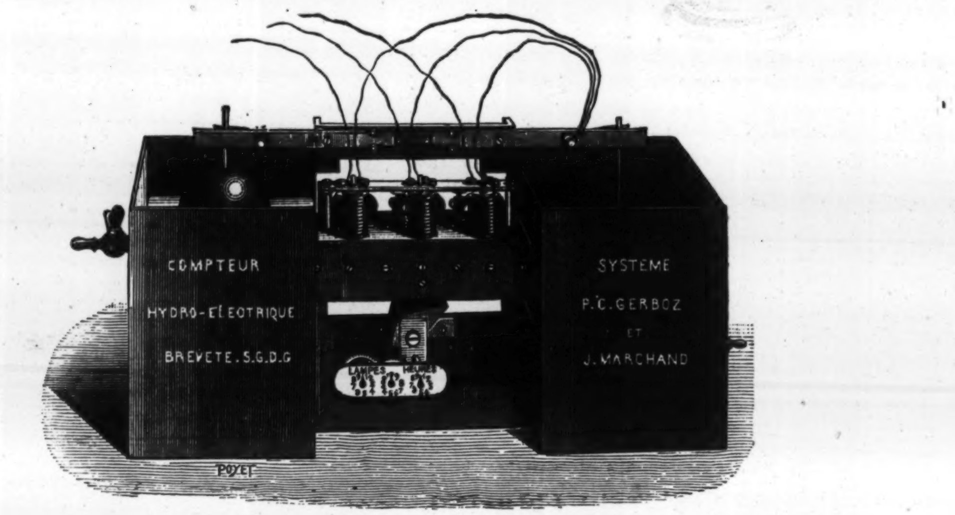
The principle upon which the apparatus is founded seems to us (*La Nature*) worthy of being pointed out to our readers. The hydro-electric meter is not the first electric measuring instrument that has been devised. The problem, already taken in hand by numerous physicists, has been repeatedly solved, but all the inventors have chosen as their object the absolute quantity of electricity to be measured. They have thus been led to a great complication of mechanism, so that if these instruments are excellent for a laboratory and for absolute measurements they are less adapted for a continuous industrial use, as, for example, for the applications of the electric light.

But this is the object which MM. Marchand and Gerboz have sought to obtain. They have modified the problem, and instead of measuring the absolute quantity of electricity they have determined the time during which an electric current, supposed to be of known and constant force, has been employed. In fact it concerns a consumer of light very little to know the absolute quantity of electricity expended provided that the lamps have acted regularly. But it is of importance for him to know how long the lamps of the type which he employs have been in action, for this is what he considers as his consumption, and it is this which decides the amount of his indebtedness to the producer.

MM. Marchand and Gerboz have conceived their apparatus as follows :—

According to an elementary principle of hydraulics it is known that the outflow of a liquid by a given orifice under constant pressure yields quantities of this liquid proportional to the duration of the efflux. The inventors have then supposed that water placed under these conditions arrives at a depth of some millimetres above a plate, pierced with as many holes of equal diameter as there are lamps fixed in a given circuit (3 in the figure). Each of these holes when the circuit is open is hermetically blocked by a valve placed vertically, and terminated by a cylindrical muff of soft iron which forms part of the armature of a small electro-magnet. The wire of this latter in turn belongs to the derivation of a lamp. Thus each lamp has its own separate electro-magnet, its valve and its orifice in the plate, constituting an independent system. This being established, if the lamp is lighted the current magnetises the soft iron, the valve is raised, the corresponding orifice of the plate opens and remains free as long as the valve is uplifted, that is, during the entire time that the lamp is in use.

The moment it is extinguished the valve falls back under the influence of its own weight, and the efflux of the liquid ceases. This operation repeated on two, three, &c., lamps, gives a double, triple, &c., loss of liquid, that is to say, one strictly proportionate to the consumption of light. To estimate this it is only necessary to measure the loss of water. For this purpose, as it escapes the liquid is collected in a small reservoir in form of a funnel perforated in its central part by an orifice, whence it falls upon a double cup. This is mounted upon an axle around which it can revolve, and presents successively each of its two spouts opposite the orifice, and thus takes an alternating motion under the weight of the water. Each oscillation moves by a notch an escapement wheel, which finally impels a meter with a train of wheel work exactly similar to that of a common gas meter. Thus the movement of the index fingers on a dial plate shows the effective consumption.



To show that practically nothing stands in the way of substituting an industrial type for the experimental model in question, we will indicate in a few words the ingenious arrangement for suspending the service of the lamps if the action of the meter is interfered with by accident or by fraud. We refer to the figure.

We must first mention that in order to obtain a constant level of efflux, the constructor causes the current to traverse a lever, one end of which establishes by contact the continuity of the circuit, while the other is fitted with a float. This latter plunges into a cistern, which serves to supply the liquid. When the level of outflow has been reached the float keeps its rod horizontal and the circuit is closed, but if the level rises or falls the lever connected with the float ceases to be horizontal, the contact is destroyed, and the lamps in the circuit go out. This lever is further utilised for another purpose of some importance. Its pivot governs the entrance cock for the water, the influx of which therefore depends on the movement of the levers. Hence the water entering at any moment is exactly equal to the water flowing out, and the constancy of the level in the cistern is secured automatically and exactly.

In like manner the outflow cistern, receives a float, which acts upon a lever identical with that just described. If the water cannot escape freely the level rises, the lever is raised with the float, the contacts are broken and the lamps go out.

## ON A NEW CURRENT MEASURER.

By M. F. DE LALANDE.

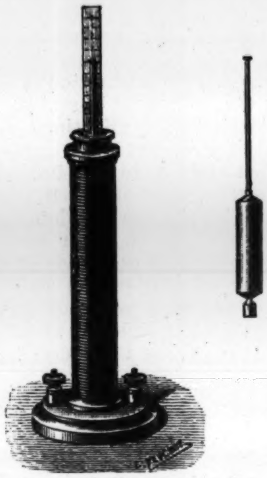
THE apparatus for measuring electric currents, based on the employment of magnetic needles or of permanent magnets are, as we know, affected to a great degree both by the variation of terrestrial magnetism and by the variation of the magnetic condition of the magnets themselves. The indications furnished by instruments of this kind, provided with a fixed graduation in ampères or in volts, cannot present guarantees of accuracy except their calibration is verified at short intervals of time. This is a serious inconvenience, especially for industrial applications, for which these instruments otherwise have the great advantage of furnishing direct and continuous indications.

The ampèremeters and voltmeters which I have the honour of laying before the Academy do not include any permanent magnet in their structure, and are consequently not liable to the cause of error just mentioned. They are based upon the action exerted by a solenoid upon a bundle of wires of soft iron, movable in its interior, and maintained by an antagonistic force. They belong to the type of Becquerel's electro-magnetic balance, and enable us, so to speak, to *weigh* the electric action of the currents.

To obtain this result the apparatus, which might be called an *electric areometer*, is simply formed of a bundle of wires of soft iron, placed in the interior of a metallic areometer plunging into a test-tube filled with water, and encircled by a coil which is traversed by the current to be measured. The initial position of the areometer (regulated by the level of the liquid, which is kept constant) being always the same, it will be understood that it will take a fixed position of equilibrium by sinking to a certain depth, variable for each intensity of the current which traverses the coil, but constant for the same intensity. The upper portion of the stem of the areometer is flat, and constitutes the index which plays along a vertical scale graduated experimentally. An important feature is the guidance of the stem of the areometer, which traverses a metal eye below the surface of the liquid. This arrangement suppresses friction against the sides of the glass, and does not affect the sensitiveness of the areometer.

By causing the dimensions of the coil and those of the bundle of soft iron wire, or of the stem of the areometer to vary, we may obtain for a given intensity a range as great as it may be desired. In the ordinary models, very skilfully constructed by M. J. Carpentier, who has studied all their details with great care, a displacement of 0·10 metre corresponds to an intensity of 10 to 25 ampères, according to the apparatus, or to a difference of potential of 100 volts.

The coils of the ampèremeters are formed of one or two layers only, of very thick wire; their resistance can only be from $\frac{1}{100}$ to $\frac{2}{100}$ of an ohm. Hence the apparatus can be introduced without inconvenience into most electric circuits. The coil of the voltmeter is of fine wire, and has a resistance of about 1,700 ohms.



The curves representing the displacement of the areometer as a function of the intensity, or of the electromotive force of the currents, present a point of inflection near which they do not differ much from a straight line. The variables have been determined in such a manner as to utilise especially this part of the curve.

The apparatus is distinctly aperiodic, it is not perceptibly affected by variations of temperature; its indications are not modified by the proximity of large masses of metal or of magnets, even if very powerful. We may add that the instrument is being introduced into this country by Mr. J. A. Berly.

## THE GROWTH OF ELECTRIC LIGHTING.

FEW facts exemplify so well the advance of electric lighting in this country, says the New York *Electrical World*, as the growth of the Thomson-Houston Company's business. Subjoined is a list of the plants newly installed or increased since January 1, 1885:—

| | |
|---|---|
| St Louis Thomson-Houston Electrical Company ... | 135 increase |
| Excelsior Electrical Company, Port Huron, Mich.... | 101 new |
| Carew Manufacturing Company, South Hadley, Mass | 10 ,, |
| Windsor Locks Steel Company, Windsor Locks, Conn. ... ... ... ... ... ... ... | 10 ,, |
| Thomson-Houston Electric Light Company, Philadelphia ... ... ... ... ... ... ... | 465 increase |
| Atchison Electric Light and Power Company, Atchison, Kan. ... ... ... ... ... ... | 30 ,, |
| Syracuse Electric Light and Power Company, Syracuse, N. Y. ... ... ... ... ... ... | 30 ,, |
| Georgia Electrical Light Company, Atlanta, Ga. ... | 45 new |
| Champion Electric Light Company, Springfield, O. | 30 increase |
| Worcester Electric Light Company, Worcester, Mass. ... ... ... ... ... ... ... | 40 ,, |
| W. A. Foote, Adrian, Mich. ... ... ... ... | 60 new |
| Leavenworth Coal Company, Leavenworth, Kan. ... | 50 increase |
| Jacksonville Electric Light Company, Jacksonville, Ill. ... ... ... ... ... ... ... | 30 new |
| J. C. Regan, Omaha, Neb. ... ... ... ... | 120 ,, |
| Thomson-Houston Electrical Company, Rockaway Beach, L. I. ... ... ... ... ... ... | 45 ,, |
| Thomson-Houston Electric Light Company, Long Branch, N. J. ... ... ... ... ... ... | 90 ,, |
| M. Shall, York, Pa. ... ... ... ... ... | 90 increase |
| Terre Haute Electrical Light and Power Company, Terre Haute, Ind. ... ... ... ... ... | 110 new |
| North Adams Electrical Light and Power Company, North Adams, Mass. ... ... ... ... ... | 38 new |
| Norwich Electrical Light Company, Norwich, Conn. | 76 new |
| Springfield Electrical Light Company, Springfield, Conn. ... ... ... ... ... ... ... | 136 ,, |
| Electrical Lighting Company, Mobile, Ala.... ... | 50 ,, |
| Newport Illuminating Company, Newport, R. I. ... | 113 ,, |
| Bangor Electrical Light and Power Company, Bangor, Me. ... ... ... ... ... ... | 114 ,, |
| Thomson-Houston Electrical Light Company, Asbury Park, N. J. ... ... ... ... ... | 45 ,, |
| Poughkeepsie Electrical Light and Power Company, Poughkeepsie, N. Y. ... ... ... ... ... | 76 ,, |
| Thomson-Houston Electrical Light Company, Plainfield, N. J. ... ... ... ... ... ... | 45 ,, |
| Merchants' Electric Light and Power Company, Boston, Mass. ... ... ... ... ... ... | 90 increase |
| Columbus Electric Light and Power Company, Columbus, O. ... ... ... ... ... ... | 25 ,, |
| Cleveland Electric Light Company, Cleveland, O.... | 180 new |
| New Haven Electric Company, New Haven, Conn. | 45 increase |
| Hartford Electric Light Company, Hartford. Conn. | 125 ,, |
| Pawtucket Electric Light Company, Pawtucket, R. I. | 45 ,, |
| Connecticut District Telegraph and Electric Company, Waterbury, Conn. ... ... ... ... | 45 ,, |
| Lewiston and Auburn Electric Light Company, Auburn, Me. ... ... ... ... ... ... | 38 ,, |
| Consolidated Electric Light Company, Portland, Me. | 55 ,, |
| Citizens' Electric Illuminating Company, Brooklyn, N. Y. ... ... ... ... ... ... ... | 180 ,, |
| Municipal Electric Light Company, Brooklyn, N. Y. | 135 ,, |
| C. E. Rector, Chicago, Ill. ... ... ... ... | 12 new |
| Badger Electric Company, Keokuk, Iowa ... ... | 60 ,, |
| W. D. Black, New Milford, Conn. ... ... ... | 38 ,, |
| V. Q. Irwin, Crawfordsville, Ind. ... ... ... | 42 ,, |
| Montana Mining Company, Marysville, Mont. ... | 6 ,, |
| Salem Electric Light Company, Salem, Mass. ... | 30 increase |
| United States Electric Company, Washington, D. C. | 90 new |
| Lansburgh & Bro., Washington, D. C. ... ... | 20 ,, |
| Woodworth & Lothrop, Washington, D. C. ... ... | 10 ,, |
| National Hotel, Washington, D. C. ... ... ... | 10 ,, |
| Steere Worsted Mill, Providence, R. I. ... ... | 38 increase |
| Wm. Tinkham & Co., Harrisville, R. I. ... ... | 40 new |
| Bethlehem Electric Light Company, Bethlehem, Pa. | 76 increase |
| Freeport Gas, Light and Coke Company, Freeport, Ill. ... ... ... ... ... ... ... | 60 new |
| Pontiac Electric Light Company, Pontiac ... ... | 25 ,, |
| Pliny Norcross, Janesville, Wis. ... ... ... | 60 ,, |
| Brookline Electric Light Company, Brookline, Mass. | 90 ,, |
| Narragansett Electric Light Company, Providence, R. I. ... ... ... ... ... ... ... | 295 increase |
| Aqueduct, New York ... ... ... ... ... | 95 new |
| Oshkosh Electric Light and Power Company, Oshkosh, Wis. ... ... ... ... ... ... | 60 ,, |
| Thomson-Houston Electric Light Company, Elmira, N. Y. ... ... ... ... ... ... ... | 45 increase |
| J. P. Dieter, Portsmouth, O. ... ... ... ... | 45 new |

## NOTES.

**Electric Lighting on Morecambe Promenade.**—In accordance with a resolution passed by the Morecambe Local Board, Messrs. Paterson and Cooper recently erected, through their representatives, Messrs. Woodhead and Preece, of Leeds and Bradford, two of their improved Pilsen arc lamps for the Local Board to test the adaptability of the system. The installation was run for fourteen days, and gave general satisfaction.

**Electric Lighting of Mills.**—Messrs. John Shaw and Sons, Limited, Stainland, near Halifax, extensive woollen manufacturers, have adopted the electric light in the whole of their dye houses, the installation consisting of twelve 1,000 C.P. Pilsen arc lamps. The installation was carried out for Messrs. Paterson and Cooper by Messrs. Woodhead and Preece.

**Electric Lighting at Santiago and Valparaiso.**—In the City of Santiago there are some 2,000 incandescent lights being maintained from a central station. In Valpariaso there are 110 Brush lights employed in lighting the General Post Office, hotels, dining-rooms, billiard halls and shops. The Brush people have lately exhibited a tower-light consisting of five 4,000 candle-power lights, mounted on a mast 65 feet high, which is located on a hill some 200 feet high in the heart of the city. This light is seen at sea over thirty miles away, and similar lights are soon to be employed in lighting the towns of the interior.

**The Thomson-Houston Lights.**—The Providence Electric Light Company (Thomson-Houston), is increasing its plant to a capacity of 470 arc lights. At the present time the company is lighting 205 lamps, but has nearly 100 additional orders waiting. A number of the Stanley-Thomson incandescent lamps are also in use on the arc circuits.

**Lighting of Theatres.**—Electric lighting, we are told by our American contemporaries, is becoming a leading feature of theatres and theatricals there.

**Electric Lighting in the Navy.**—The *Devastation*, Captain Luxmore, left Portsmouth Harbour and anchored at Spithead on Tuesday morning, preliminary to superseding the *Lord Warden* as coastguard ship at Queensferry. Since her return from the cruise of the Evolutionary Squadron she has had her bunkers ventilated upon a new principle, and has been fitted with dished torpedo ports, for the purpose of keeping out the water, and with the electric light.

**The Schuyler Light in New England.**—The Hartford, Conn., correspondent of the *Electrical World* states that the business of the Schuyler Electric Light Company is steadily increasing. During the past few weeks the company has been engaged filling orders for the following :—New 100 arc light plant at Elizabeth, N. J. ; new 100 arc light plant at Columbia, Pa. ; new 75 arc light plant at Skowhegan, Me. 50 arc lights at Middletown, Conn., have been added, the city authorities having ordered out all the gas and oil street lamps formerly in use, and at New Britain, Conn., the company has added 58 arc lights, the number previously installed on trial being only 17. The first installation of 17 lights had been running but 30 days, and during that time the municipal officers subjected them to all manner of tests, only to become more thoroughly satisfied with the system, and they then and there ordered out all the gas street lamps and instructed the Schuyler Company to put in the additional number above mentioned. At Danbury, Conn., the company first installed 75 arc lights, a portion of them on towers, and the citizens were so well pleased with the system that orders have been given to increase the plant to 125 lights.

**The United States and the Bell Patents.**—Solicitor-General Goode, who, as acting Attorney-General, gave permission for the suit against the American Bell Telephone Company to be brought in the name of the United States, has, upon pressure from the President, directed the suit to be withdrawn.

**American Patent Law.**—A statement of Mr. Dickerson that no law could be found for the United States assailing Bell's telephone patents, is confirmed in a singular manner. A bill giving the Attorney-General peculiar powers in instituting suits against fraudulent patents was favourably reported by the House Committee on Patents, but on search it has mysteriously disappeared from the files of Congress. The engrossed copy of this bill, together with all documents and papers relating to the measure, has disappeared from the files of the Senate Committee on Patents. Senator Platt, Chairman of the Senate Committee on Patents, has written to Washington that he wants the matter probed to the bottom.

**The Telephone at Whitehaven.**—At a *conversazione* of the Whitehaven Scientific Association, amongst the exhibits of interest was a collection of telephonic apparatus lent by the National Telephone Company, and during the evening the hall was connected with the company's system, and visitors were enabled to converse with persons at several adjacent towns. Mr. A. R. Bennett, general manager of the National Company, gave a descriptive sketch of the history of the telephone which was much appreciated.

**The Telephone in the Northern Counties.**—The Northern District Telephone Company is pushing on its work very satisfactorily, in the county of Durham particularly, and will soon have all the principal towns connected. Already the company has had exchanges working very satisfactorily for some time at Sunderland, North and South Shields, Tyne Dock and Yarrow, which places are all in communication with one another and with Newcastle ; while the trunk line between Sunderland and Hartlepool is being brought forward with the greatest energy. An exchange will shortly be opened at Darlington, which town, with Stockton and Middlesbrough, will form important links in the chain of telephonic communication. The company has to compete with the Post Office in almost every town in the district, but with the exception of Newcastle, in which place the Post Office is very strong, the competition does not appear to affect the company to any great extent. Mr. R. A. Dalzell, late of the United Telephone Company, has been appointed inspector at the company's exchange at Newcastle. A good deal of trouble is experienced sometimes in getting wayleaves from people living in the country, who apparently think that the company is anxious to plant its poles in the middle of the roads, and do other variously absurd and wicked things, while they cannot get over the feeling that there is something uncanny and jeopardous in having the wires attached to their houses.

**The Reis Telephone.**—The Orange, N. J., *Chronicle* says : Professor J. R. Paddock, of Stevens Institute, who resides on East Park Street, East Orange, has been engaged the past summer in important investigations as expert for the Overland Telephone Companies of New Jersey and Pennsylvania, in the suits pending in the United States Courts for infringement of Bell's patents. The defence rests in part upon the inventions of one, Phillipp Reis, of Germany, who it is claimed invented a talking telephone fifteen years before Bell's telephones were patented. Professor Paddock received some time since the *original instruments of Phillipp Reis* from Frankfort, Germany, and has been engaged with E. W. Smith, of New York, in testing their efficiency as regards this much disputed point. In their testimony before C. N. Williams, special examiner, who has been taking testimony in the case, Professor Paddock and Mr. Smith proved that for four months they had been experimenting with the Reis instruments in various forms. They gave the results in detail, and showed more clearly than has ever been done before that these instruments without any change are perfectly capable of transmitting speech. One sentence of fifty-six words was spoken by Professor Paddock and received by Mr. Smith by a Reis transmitter of the cubical box form without carbon points, and a knitting needle receiver. They also proved that *the identical telephone used by Reis at his lecture in* 1861 will transmit speech without any alteration. They stated that they had used it in Professor Paddock's laboratory on a line from the house to the stable 350 feet, and had succeeded in sending many words and short sentences and the words and music of various songs. They were surprised at the result, because they did not think it probable that the actual membrane and electrodes used by Reis twenty-five years ago would retain their properties sufficiently for actual use at this time.

**American Bell Telephone Company.**—Dr. W. W. Jacques, who has been connected with the electrical department of the American Bell Telephone Company for five years, has tendered his resignatian. Dr. Jacques is spoken of as being an accomplished electrician.

**Telegraph Revenue.**—The receipts on the telegraph service from April 1st to October 24th, 1885, amounted to £1,010,000, against £1,080,000 from April 1st to October 25th last year.

**United Telephone Company v. Bassano, Slater and Co.** — On the opening of the Law Courts, on Monday, after the Long Vacation, this case, which relates to the receiver part of the Bassano telephone, came before Mr. Justice North, who acceded to an application made by Mr. Aston, Q.C., on behalf of the United Company for a postponement until the appeal in the case tried before the vacation, concerning the transmitter, has been heard. Mr. Plumptre, for the defendants, asked for an extension of the order that the plaintiff company should make no use of the telephones given up; but Mr. Aston objecting, Mr. Justice North asked for notice of motion, which was accordingly given.

**The Telegraph in the Soudan.**—A telegraph line, it is said, exists between Omdurman and Berber.

**Persian Gulf Cable.**—We are informed that the cable steamer *Dacia* arrived at Port Saïd on the 23rd inst., and that the *International* arrived there on the 27th. These vessels are carrying out a new Persian Gulf cable, which will be laid from Task to Bashire, under the superintendence of Colonel Bateman Champain. They are expected to arrive at Task on the 21st of next month, and the cable will probably be completed by the first week in December.

**West African Cables.**—The cable steamer *Silvertown*, which left the Thames on Saturday the 10th inst., arrived at Dakar, Senegal, on the 22nd, and laid the Dakar shore end of the West African Company's cables on the 24th. This vessel is now sounding between Bathurst at St. Thiago (one of the Cape de Verde islands) and returns to meet the *Buccaneer*, her tender, on the 29th inst. The laying of the cables will then be proceeded with connecting up St. Louis du Senegal, Dakar, Bolama, Bissáu, and Conakry. Should landing permission be granted by Her Majesty's Government, Bathurst and Sierra Leone can also be connected up easily, as Conakry is only some ninety miles to the north of Sierra Leone, and Bathurst lies between Dakar and Bolama. When the system is complete, all the stations above-mentioned will have a duplicate route to England, either *viâ* the Spanish National and Direct Spanish lines or by the Brazilian Submarine and Eastern Company's cables. The *Buccaneer* has been specially fitted for sounding work and has a high rate of speed, and so soon as the cables are laid by the *Silvertown* she will proceed to sound over the route, and visit the stations of the extension of these lines, which will be laid next autumn and winter, during the healthy season on the West Coast. Her Majesty's Government is sending out the surveying vessel, *Sylvia*, to determine the longitudes of different points along the West Coast of Africa, and the West African Telegraph Company has placed its cables at the disposal of the hydrographer, Captain Wharton, R.N.

**A Compound Galvanic Battery.**—Can any of our readers inform us of the difference existing, if any, between patent No. 13,759 (see p. 383) and Planté's old arrangement of charging his secondary cells and afterwards making use of the current produced by them?

**Sale of Electric Lighting Plant.**—The sale of the effects of the Hammond Electric Light and Power Company was continued on Tuesday, Wednesday, Thursday, and Friday this week, by Messrs. Wheatley Kirk, Price and Goulty. The sale has been by far the largest dispersion of electrical plant that has ever taken place in this country, and has been well attended. Prices, however, have ruled low, and an opportunity is now afforded of buying dynamos at prices quite unprecedented. One buyer at the sale is already offering Ferranti dynamos for 150 incandescent lamps at £50 each, and Gramme dynamos, suitable for exciting the Ferranti machines, or for other purposes, at £22 10s. each.

**Underground Wires in Chicago.**—The Chicago *News*, of September 26th, says: "If New York really wants to clear its streets of telegraph poles and electric wires, let her send the Electrical Subway Commission or the 'experts employed by the companies,' to Chicago. Here they can see the first electrical subway (Dorsett system) ever constructed for practical work, and the wires to-day, after nine years' continuous service, as perfect as ever and still doing daily duty. They can find over 1,000 miles of underground wires—telegraph, telephone, fire alarm, electric light, &c. And if they don't come pretty soon they will not be able to find a single line of wire above ground for any purpose within the city limits."

**Transmission of Power in Canada.** — The most ambitious project yet broached for employing electricity as a universal motor is at present under consideration at Quebec, states the *Electrical Review* of New York. It has its origin in the successful use already made at Montmorency Falls as the source of power for lighting Dufferin Terrace by electricity. It is now proposed to put the famous waterfall at work not only to run a short electric railway, but to furnish electric power superseding steam in all the factories and workshops of Quebec. It is clear that the disposition to use electricity as a motive power is again becoming urgent. For a time its work in lighting absorbed attention, and certain objections on the grounds of economy, convenience and safety also seemed to oppose obstacles to immediately employing it for transportation. But now both in New York and Philadelphia this use is again seriously urged. In Philadelphia, we believe, an electric railway is expected to be regularly running within a month, and in New York the experiments with electric motors on the Ninth Avenue elevated road continue to be made. Quebec, however, will be entitled to take the lead, for the present, in widening the uses of electricity, if she really succeeds in carrying into effect her projected work with the Montmorency Falls.

**The Blackpool Electric Tramway.**—The Blackpool *Times* of the 21st inst. contained the following item:—The open electric car, the property of Mr. Holroyd Smith, was running yesterday all day, between Claremont Park and the South Shore Hydropathic Establishment. So far as the electrical portion was concerned, the car appeared to run without a single inconvenience. The "points," however, continue to cause no small amount of trouble, and especially is this the case when the cars are being propelled by electricity. On two occasions yesterday, the open car took the wrong siding, and but for the careful and due control on the part of the driver, an accident in all probability would have occurred with a car that was proceeding in the opposite direction. It is a rather curious fact that whenever the waggon-like car is being run, it manages to travel with the greatest ease, whilst the large cars have usually frequent stoppages at unexpected intervals.

**The Daft Motor.**—The Daft electric motor, the "Ben Franklin," had a fairly but not entirely successful public trial trip in New York City on the evening of the 1st inst. According to the *American Engineer*, it demonstrated, however, its ability to draw a train of four cars on the 9th avenue elevated road, and that the power was under adequate control, even when Messrs. Jay Gould, Sidney Dillon, Russell Sage, and other railroad magnates were among the party on board and helped to swell the weight of the four cars to fifty tons. Further modifications will, however, be necessary before the motor can be pronounced a complete mechanical success, but the projectors are confident that this is a matter of only a few weeks' time.

**Personal.**—The manager of the West African Telegraph Company, Mr. E. W. Parsoné, left for Praia, St. Thiago, on Saturday last, aboard the royal mail steamship *Tamar*, viâ Lisbon.

**The Inventions Exhibition.**—In an article upon the now expiring Inventions Exhibition, the *Contract Journal* says:—"In our opinion the South Kensington Bonanza has from the beginning been a gigantic failure. Its promotors, anxious to make money, have adopted that principle as a fundamental one by which their every action was to be guided, and have cared for little else, either in the directions of consulting the necessities of exhibitors or the requirements of the British public. . . . . In regard to the proposed exhibition in 1886, we are of opinion that if a distinct improvement is not shown in the management, it will be a disastrous affair for its promotors. The British public and the British Press are long-suffering; but both have their limit of endurance. It would be well also if the lines upon which the next show is to be laid down were to diverge from those with which we are already too familiar. The 'Fisheries,' the 'Healtheries,' and the 'Inventories' present a strange anomaly when comparatively viewed. An improvement and a deterioration have been manifested. As collections of the 'products of men's minds in infinite variety,' and as examples of the industry of electric lighting, they have been progressive, but in all else a decidedly backward tendency is observable. . . . . The International Inventions Exhibition, properly administered and effectively arranged, should have commanded the respect and admiration of Europe. It should have been a stranger to favouritism and above jobbery. Its trials of machinery in general should have been exhaustive, and its awards recognised diplomas of excellence. As it is, nothing has been done; the outcome of it all is *nil*, comparatively speaking. Individual opinions have been formed, and are in no way disturbed by the verdicts of the jurors. The fact of anyone having received an award is just this: He has a good article. No more. It does not argue that it is superior to others of exactly the same kind which may also be exhibited. In several cases which have come under our notice the awards have not been warranted by the facts; nay, more, they have been illusory."

**Popular Science Lectures.**—Amongst the Penny Science Lectures to be given at the Royal Victoria Hall and Coffee Tavern, Waterloo Bridge Road, during the coming weeks, we note one on "Electrical Fire Alarms in America," by Mr. W. Lant Carpenter.

**Mr. Pender and the Western Union.**—Speaking of Mr. John Pender's resignation from the board of directors of the Western Union Telegraph Company, the *Financial News* remarks:—"There is no reason to fear that Mr. Pender's retirement from the board of Mr. Jay Gould's company will deprive the investing public of his valuable services; he will continue to devote such time as he can spare from his private business and his Parliamentary duties to attending to the affairs of the following companies, of which he is still a director:—The Direct United States Cable Company; Eastern and South African Telegraph Company; Eastern Extension Telegraph Company; Eastern Telegraph Company; Globe Telegraph and Trust Company; Isle of Man Railway Company; London Platino-Brazilian Telegraph Company; Oude and Rohilkund Railway Company; Panulcillo Copper Company; Railway Debenture Trust Company; Railway Share Trust Company; Submarine Cables Trust; Young's Paraffin Light and Mineral Oil Company."

**The Oppermann Failure.**—Mr. Oppermann, the manager of the Chicago branch of the firm of Messrs. Oppermann Brothers, has been interviewed for information regarding the failure of the English house, and has stated that he knew nothing personally regarding the matter, and was taken entirely by surprise by the intelligence; and that, while he knew that six months ago the London house had $10 assets for every dollar of liability, he knew nothing now of its indebtedness. He purposed continuing the business in Chicago as before, without reference to the London house, and was then busy completing a large order to be finished by the last day of September.

**Partnership.**—Mr. Charles R. Heap, of 62, Coleman Street, E.C., electrical engineer, has entered into partnership with Mr. Francis E. Stuart, of London, to carry on the business of electrical engineers and contractors under the style of Heap and Stuart. This firm will shortly remove to more convenient premises, of which notice will be duly given. Mr. Stuart was several years with Mr. C. E. Spagnoletti, C.E., of the G.W.R.

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**Electrical Transmission of Power.**—A Reuter's telegram reports that at Monday's sitting of the Academie des Sciences M. Marcel Deprez communicated the result of some experiments, made between Creil and La Villette, over a distance of 58 kilometres for the electrical transmission of power. M. Deprez stated that complete success was obtained, inasmuch as he had effected the transmission of 40 horse-power out of 80 over the line, without the current heating the wire or the machine. The costs of the experiments were defrayed by M. de Rothschild. We must await the receipt of more definite particulars before making any critical comments upon the brief statement contained in the above telegram. Does it mean that M. Deprez with an initial 80 H.P. was able, at a distance of, say, 34 miles, to obtain 40 available H.P. developed by the motor at the receiving end?

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**The Grosvenor Gallery Lighting.**—The large Phœnix dynamo which has been running for lighting the dining rooms at the Inventions Exhibition has been purchased by Sir Coutts Lindsay and Company, Limited, for the Grosvenor Gallery central station.

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**"Perfect" Pulleys.**—Messrs. George Richards & Co., who give this name to the pulleys they manufacture, have just issued a handy, well printed, comprehensive, and interesting price list. From it we learn that the new works erected for the firm at Broadheath, near Manchester, only a year or two years ago, are already found too small for their rapidly increasing business, and that a very large addition is being made. The whole of the works are entirely lighted by electricity the installation having been the work of Mr. Chas. Lever, who resides in the same locality. The pulleys are made on the "Medart" system, the rims, which are subject to tensile strain, and liable to be broken by accident, being made of wrought iron or steel; and the boss and spokes, which require stiffness, and are subject to compressive strain, being of cast iron. The spokes brace the rim, and the rim braces the spokes; and it is claimed that the combination secures the greatest possible strength. It is stated that the Medart Company and their licensees make 450 pulleys per day, and that there are from 200,000 to 250,000 at present in use. The list contains valuable information for buyers, not only as to pulleys, but also shafting, shaft fittings, and other matters.

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**The Pyrophone.**—We are the recipients of a circular describing the electric singing lustre (chandelier or gaselier), invented by the late F. Kastner, which is stated to be an electric pyrophone in the form of a chandelier, lighted and worked by the medium of gas and electricity, and of which thirteen glass tubes, with their numerous small gas-burners, constitute the branches. This lustre is played by means of an electromagnetic apparatus with a key-board. The electric current is transmitted by the agency of wires, concealed in the ceiling and communicating with the key-board, which may be placed in the next room, or even in a remote apartment or another street without the audience being able to comprehend whence the music comes. Two electric singing candelabra or brass ornamented electric singing chandeliers are exhibited at the International Inventions Exhibition. They are moved by electromagnets, so that they may be played from a remote apartment and in the same manner as the lustre. They are most easily transportable, and each of them may be adorned with a Geissler tube in the shape of a lyre, or with small electric lamps to double the illumination.

**The Leeds Corporation and Electric Lighting.**—A special meeting of the electric lighting committee of the Leeds Corporation was held at the Municipal Buildings on Saturday evening, Councillor W. H. Lee Hardwick presiding, for the purpose of inspecting the plant and machinery employed in the electric lighting of the Free Public Library in the Municipal Buildings with incandescent lamps, the two dynamo machines originally supplied by the contractors (Messrs. Paterson and Cooper) having been removed, and the two new dynamos constructed by them being now at work in the basement of the Municipal Buildings. According to the terms arranged between Mr. Morrison, as solicitor for the Corporation, and Messrs. Routh, Stacey and Castle, as solicitors for Messrs. Paterson and Cooper, for the settlement of the action commenced by the contractors against the Corporation, each dynamo was to be capable of giving an electrical output of 9,000 watts, and of running with the present gas engines 142 20 candle-power lamps. The dynamos were further to be capable of giving an electrical output of 12,500 watts, and of running twelve hours continuously without overheating, if the Corporation provided adequate power. At the meeting of the committee on Saturday evening, the Town Clerk (Mr. Morrison) reported that he had that morning received from Sir Frederick Bramwell, the President of the Institute of Civil Engineers, who, by the terms of settlement, was appointed to test the dynamos on behalf of the Corporation, a report to the effect that the two new dynamos constructed by Messrs. Paterson and Cooper had been duly tested by him in London, and found to be, as regards their electrical output, not only fully up to but above the actual requirements of the terms of settlement, the excess being to the extent of more than 20 per cent. above the electrical output specified in the terms of settlement. The borough engineer (Mr. T. Hewson) reported that having completed the alterations necessary for increasing the power by coupling the two gas engines (two 12 H.P. nominal engines of the "Otto" type, built by Messrs. Crossley Brothers, Limited, of Manchester, and having all their latest improvements), he had made thorough and independent tests on the premises as to the efficiency of each dynamo when in actual work, with the result that the tests fully confirmed those made by Sir Frederick Bramwell as to the electrical efficiency of the machines. The committee, having carefully inspected the whole of the machinery, fittings, and lamps with which the rooms are lighted, and which gave an exceptionally steady and bright light, expressed themselves perfectly satisfied with the installation, considering that the ratepayers have now obtained one of the best systems of electric lighting by incandescent lamps (with gas engines for power) in either London or the provinces.

**Prolific Inventors.**—American exchanges state that in the list of September 29th, forty-three patents, all bearing the same date, were issued to one inventor, H. C. Spalding, of Boston. The largest number heretofore issued to a single inventor at one time is said to be twenty-six, which were granted to a resident of Indiana. Edison and Weston have each obtained twenty-five in one week, but now the record has been broken by a New Englander, who scores nearly double that number, and has ten or fifteen more cases pending.

**Gas Explosion.**—About nine o'clock on Tuesday night an explosion of gas, by which two persons were injured and a floor was nearly wrecked, occurred at the British and Foreign College, Stockwell. Two bags of oxygen and hydrogen had been brought into the ground floor of the institution in connection with an entertainment or lecture, and suddenly a loud explosion occurred. There were two persons near at the time, Mr. George Hayler and Mr. S. D. J. Skertchly. Both these gentlemen were blown across the room, and sustained rather severe bodily injuries. The contents of the room were shattered, but the fire which followed was promptly subdued by the inmates.

**Ball of Electric Fire.**—A correspondent writes to *Science* that :—Mr. J. V. Wurdeman says that a ball of fire, as large as a child's head, came into his room at Leavenworth, hopped across the floor like a soap bubble rolling on a carpeted floor, went out through the side of the house at the corner opposite to where first seen, with a sort of explosion, or rather puff, not nearly so loud as a pistol shot nor so sharp, and tore off the rain pipe of tin. It looked like an electric brush, not brilliant nor like the electric spark. His son, a little child, was playing on the bed ; his mother snatched up the boy and was half way down stairs before the ball disappeared. The ball seems to have been like the St. Elmo lights, which I have seen on a vessel's yardarm, in the Gulf of Mexico, a pale brush of light, spherical in form, like the brush issuing from a metallic point in the prime conductor of the frictional electric machine.

**Testimonial to Sir P. Cunliffe-Owen, C.B.**—Perhaps as startling an example of the gilding of gold as could well be imagined was the little ceremony which took place at the banquet at the Criterion, on Thursday, when Sir Philip Cunliffe-Owen, C.B., was presented, in the name of the British Exhibitors at the International Exhibitions which have been held during the past three years at South Kensington, with a purse of 4,000 guineas and a salver, a pair of diamond earrings being at the same time presented to Lady Owen. The invitations to the dinner, at which Mr. Chas. Galloway presided, were limited to the vice-presidents of the exhibitions, the members of the committee, and the officers of the testimonial fund, and covers were laid for forty. The number of subscribers, we understand, was about 400, so that heavy sums were probably contributed by some among the "exhibitors." Sir Philip has doubtless contributed largely to the success of the exhibitions, but so munificent a gift to one in his position must strike reasoning minds as not a little preposterous. The amount of good which might have been achieved with those thousands, if expended in a sensible manner, is immense, and we can only look upon this method of its outlay as outrageously wasteful. Can it be, however, that those who most extensively contributed did so in the hope of seeing a fair return upon their investment?

**Telegraphic Addresses.**—We shall be glad to receive by next post, from all interested in electrical matters, their telegraphic addresses, as we purpose publishing as complete a list as possible of such addresses for the use of our readers.

**The Sale of the "Great Eastern."**—On Monday a motion was made before Mr. Justice Chitty in an action of "Marsden *v.* Newton" on behalf of the liquidator of the *Great Eastern* steamship for the sanction of the Court to the acceptance by the liquidator of an offer of £20,500 for the purchase of the ship. The vessel was advertised for sale by auction on Wednesday, and several private offers had been made since the order of the Court for the sale issued. The £20,500 is the largest sum yet offered, and the liquidator's affidavit was to the effect that he believed so large a sum would not be acquired under the hammer. Mr. Justice Chitty refused his sanction, and said it would be better for the auction to proceed.

## OFFICIAL RETURNS OF ELECTRICAL COMPANIES

**Pyramid Electric Company, Limited.**—A meeting of this company was held on the 16th inst, when an account was given of the manner in which the winding up of the company has been conducted and the property disposed of. The return of the final winding up meeting was duly filed on the 17th inst.

## CITY NOTES.

**The Telegraph Construction and Maintenance Company, Limited.**—It is announced that the twenty-first distribution of the certificates of the Second Bonus Trust, issued under the Trust Deed of March 12th, 1875, will be made on and after December 2nd next. The distribution will be at the rate of 1s. 1d. per £5 certificate, payable two clear days after presentation of coupon No. 21 at Messrs. Barclay, Bevan and Co.'s Bank, 54, Lombard Street, E.C.

**The Eastern Extension Australasia and China Telegraph Company, Limited.**—This company notifies that the coupon on its Five per Cent. Manila debentures (1880, June), due on the 1st prox., will be payable on and after that date on presentation of the same at the Consolidated Bank, 52, Threadneedle Street, E.C. Coupons should be left three clear days for examination.

**The West India and Panama Telegraph Company, Limited.**—At a meeting of the directors held on Wednesday, it was decided to place £6,000 to reserve, and to recommend to the shareholders at the approaching meeting that a dividend of 9s. per share be declared on account of arrears of dividend on the first preference shares.

**Electric "Sun" Lamp and Power Company, Limited.**—The resolutions relating to the voluntary winding up of this company, passed on the 22nd ult., were confirmed at a meeting held at 8, New Square, on the 15th inst. The office of the company is removed to 5, Bombay Street, Bermondsey, S.E.

**Consolidated Telephone Construction and Maintenance Company, Limited.**—The directors have declared a second interim dividend of £2 10s. per cent. on account of profits for the current year, and the same will be payable on and after November 12th next.

**Eastern Telegraph Company, Limited.**—This company announces the payment on November 1st of interest, for the half year ending the 31st inst., on its four per cent. mortgage debenture stock.

**Maxim-Weston Electric Company, Limited.**—This campany has secured a quotation on the Stock Exchange for shares Nos. 200,001 to 250,000.

## TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending October 23rd were £2,421, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the past week amounted to £3,137.

## NEW PATENTS—1885.

12606. "Electrical apparatus for governing or regulating electric currents." W. H. Scott, E. A. Paris. Dated October 21.

12611. "Instruments for testing electrical resistances." W. J. Murphy. Dated October 21.

12681. "Arc lamps." J. Brockie, B. Pell. Dated October 22.

12724. "Galvanic or primary batteries." J. E. Liardet. Dated October 23.

12816. "Electrical fusible cut-out or safety junction." A. P. Lundberg. Dated October 26.

12840. "Plates for batteries, especially applicable to secondary batteries, and the manufacture of the same." G. A. Mason, W. Weise, O. Romanze, F. Thornton. Dated October 26.

12851. "Conduits for electric wires and cables, and for other purposes." G. D. Sutton. Dated October 27. (*Complete.*)

12897. "Switches for making and breaking electrical contacts." F. Wynne. Dated October 27. (*Complete.*)

12906. "Electrolytic colouration of metals." A. Watt. Dated October 27.

12913. "Polarised telegraph instruments for increasing their working capacity." P. Jensen. (Communicated by R. Gulstad.) Dated October 27.

12915. "Contact makers and breakers for use in torpedoes and for other purposes." J. T. Bucknill. Dated October 27.

12921. "Means and appliances for imparting electricity to various parts of the human body." C. Brust. Dated October 27.

12932. "Electric gas lighting burners." A. J. Boult. (Communicated by D. Rousseau.) Dated October 27. (*Complete.*)

## ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1884.

13664. "Improvements in telephonic call apparatus." J. Poole and K. MacIver. Dated October 16. 6d. Consists under the first part in providing the speaking end of the circuit with signalling apparatus, and at either the speaking or central exchange end, but preferably at the speaking end, with a circuit regulator or switch, controlled by the action of spring weight or like mechanism, set in operation for a given time either mechanically or electrically from the said central or exchange station. Under the second part, counting and recording appliances of any usual or suitable kind, operated by studs, keys or other convenient means, are combined with the circuit controlling or switch mechanism for the purpose of counting and recording the number of times the circuit has been in operation. Under the third part, coin receiving appliances are combined with the circuit controlling or switch apparatus for setting the said apparatus in motion when a coin of the required value is deposited in or on the said appliances.

13744. "Improvements in primary or galvanic electric batteries and in their construction." T. Rowan. Dated October 17. 4d. The inventor constructs one of the electrodes of carbon preferably in a granulated or broken condition, which may be contained or held in a porous cell of any suitable shape, or the carbon may be surrounded by a porous diaphragm or envelope of suitable material, such as parchment paper, felt, or the like. The carbon so contained, or held, is moistened by a solution of nitrate of mercury, or nitrate of silver, or nitrate of aluminium, or nitrate of chromium, or nitrate of lead, or nitrate of copper, or nitrate of iron, or other suitable soluble metallic nitrate, or this electrode may consist of a hollow cell of carbon of any convenient shape which may be closed or sealed, and which may contain or enclose nitric acid or any suitable soluble nitrate, or the porous carbon cell may be filled with granulated or broken carbon, or any suitable porous material instead of or mixed with the granulated or broken carbon such as felt, pumice stone, &c., which may be moistened or saturated with any suitable nitrate or with nitric acid. The soluble electrode or positive electrode (forming the negative pole) is zinc, which is immersed or moistened with a solution of sal ammoniac, or common salt, or other suitable chloride.

13755. "Improvements in apparatus for telegraphing by means of reflected light." H. C. Mance. Dated October 17. 4d. Consists in the providing of the folding arm of the heliograph or sun signalling apparatus with a snap clamp, which, on the arm being lowered, instantly secures it in its horizontal position, and which can be released by the simple pressure of a thumb piece, so as to allow of the arm being put ready for working or turned up for packing instantaneously, without the necessity for screwing and unscrewing at the hinge.

13759. "A compound galvanic battery." S. H. Emmens and The United Patents Corporation. Dated October 17. 4d. Consists in constructing the battery partly of primary cells and partly of secondary cells. The cells of each class may be of any known construction. The lamp or other service circuit is attached to the poles of that portion of the battery consisting of the secondary cells, which are coupled up in series by means of cavaliers, switches, or other suitable connections capable of easy disengagement. The terminals of each secondary cell are likewise connected by cavaliers, switches, or other suitable means, with two pole pieces in communication with the poles of that portion of the battery consisting of primary cells. By this arrangement the secondary cells may be charged in multiple arc and discharged in series, and it thus becomes possible to work lamps of high resistance from a primary battery of even two cells. The inventors are furthermore enabled to keep the compound battery in perpetual operation if required. This they accomplish by using one or more secondary cells in addition to the number actually required for the service circuit, and by successively cutting out a corresponding number of such cells and switching them on to the charging pole pieces, while the primary cells, if of suitable construction, may be kept constantly replenished with anodes and electrolytes while at work.

14197. "Improvements in the preparation or manufacture of elements for primary electric batteries." C. P. Elieson. Dated October 27. 2d. Relates to improvements in the preparation or manufacture of elements for primary electric batteries, and consists essentially in first impregnating or charging carbon to be used in such batteries with oxygen, and then allowing such carbon to oxidise before being placed in the battery containing a zinc or other element, and preferably a solution of sal ammoniac or saline solution, or an acid solution or other electrolyte.

14485. "Improvements in galvanic batteries." G. Baron de Overbeck. (Communicated from abroad by Dr. F. Hornung, of Berlin.) Dated November 1. 4d. As exciting liquid for the zinc, the inventor employs an aqueous solution of common salt (sodium chloride) or potassium chloride, or else soda or potash lye. As exciting fluid for the carbon (depolarising liquid), he employs an aqueous solution of a hypochlorite (salt of hypochlorous acid) or free chloric acid or free perchloric acid.

14548. "Improvements in and connected with electric batteries or elements." P. M. Justice. (Communicated from abroad by F. Van Rysselberghe, of Schaerbeek, Brussels.) Dated November 4. 6d. The inventor separates the heavy and the lighter liquid by means of a porous membrane of goldbeaters' skin, aimanthus,

**or ordinary paper, or by a porous ring or disc of terra cotta, or the like, the same being placed in a slanting position, or in some degree away from the horizontal, the gases contained in the lower liquid being allowed to escape.**

## CORRESPONDENCE.

### Fitz-Gerald's Secondary Battery.

Although the publication of the matter contained under this heading, in your last issue, is considered in some quarters as decidedly premature, there is little to complain of in regard to its accuracy. The battery sent to Paris was, however, nominally a *half* H.P. hour cell, which had been found capable of developing ·7 H.P. hour. This particular battery, with the flexible positives described by you, is undoubtedly a *secondary* battery; since it can be discharged and recharged without any manipulation of the elements. I think it must be admitted that the *on dit* from Paris is somewhat premature; since I understand that the electrician to whom the tests have been entrusted, has not yet made his report, nor, indeed, completed his experiments. I speak with diffidence; for the managing directors of the company now standing in the shoes of the old "Fitz-Gerald Electric Light and Power Company, Limited," have not thought fit to request me to be present at the experiments made with my battery, and have, moreover, sent me a lawyer's letter forbidding me, as electrician to the company, to go to Paris even at my own expense. No doubt there are weighty business considerations on which the action of the directors is based; but in many respects it is personally offensive and detrimental to myself. For instance, a friend of mine, well-known in connection with scientific literature, was informed the other day that I do not even know what there is in the elements prepared under my supervision for the Paris experiments. On my mentioning this, on last Monday, to one of the managing directors, he informed me that, as a matter of fact, there is some innovation, in regard to the cathodes (spongy-lead elements), with which I am unacquainted. This innovation, it would appear, must have been carried into effect under my very nose, without my being informed of it, by the staff I have been instructing in the details of my invention. If this be actually the case, this fact alone indicates a condition of things in regard to the relations between the staff, the electrician, and the managing directors, which, in the interests of the company, it behoves the last-mentioned gentlemen to modify with the least possible delay.

In order to avoid future misconceptions, will you allow me to state that (*quasi* innovations notwithstanding) I claim to be the sole inventor of the processes (not one-half of which I have as yet had time to communicate to the staff of the company) under which elements of the character described in your notice may be and have been manufactured. I will wait to see whether this claim is challenged before I advance any particulars in support of it. Of course I do not mean to say that no other processes are possible or practicable, for I am now engaged in devising other processes for obtaining the same result; but I assert that, outside of my present invention (which, under agreement, will be assigned to the company I have referred to), there are no means available to the company for producing elements such as you have mentioned.

I may mention that even at the present moment, and with the plates at present being tried (which are by no means the best), it is quite possible to construct the H.P. cell under a weight considerably less than that mentioned by you, viz., 75 lbs. But there is much more work for me to do in connection with my invention, and I think that, in the meantime, those for whom I am working should protect me from the annoyance of hearing through their friends that I have nothing to do with the invention which I have so long laboured to realise.

I will on a future occasion, with your permission, say something about the properties, to which you refer, of a solution of sulphate of magnesia when employed as the electrolyte in a lead secondary cell.

**Desmond G. Fitz-Gerald.**

### The Dangers of Secondary Generators.

I notice in the correspondence columns of your issue of September 26th, 1885, a communication from J. A. Fleming, in which he suggests a remedy for the danger involved in the use of transformers or secondary generators. The remedy proposed by Mr. Fleming, that is, connecting the secondary circuit to earth, is already the subject of U. S. patent No. 322,138, filed by me April 27th, 1885, and issued July 14th, 1885, a copy of which I enclose herewith.

It will be seen that the patent describes fully not only the remedy proposed, but also describes what I consider to be as good, if not a better, disposition of the parts; that is, the introduction of a conducting septum between the primary and secondary wires of the induction coil or transformer, and the connection to earth, and in some cases to the secondary also, of this introduced metallic septum, such septum being constructed in a way to avoid wasteful induction currents.

I call attention to this patent simply in the interest of true history, and am glad to find that the same remedy has suggested itself to others, and can testify from actual experience with the invention that it is a complete safeguard against dangerous shock arising from leakages from the high potential primary coils.

**Elihu Thomson.**

Lynn, Mass., *October* 13*th*, 1885.

[We have thought it desirable to give a description of Prof. Thomson's arrangements, and this will be found on p. 366 of our present issue.—EDS. ELEC. REV.]

### Reis's Telephone.

I proved by undisputed and indisputable quotations from Philipp Reis's own memoir that in his use of the term *die Tonsprache selbst* he included vowels and consonants. Your correspondent who signs himself or herself "G. R." has asserted without one word of proof that Reis meant thereby music only. I have challenged "G. R." to give his or her name. I have denied that certain words which "G. R." put into quotation marks were a genuine quotation at all; "G. R.," when thus challenged, fails to give any authority for the alleged quotation. I have exposed "G. R.'s" ignorance about the late Philipp Reis in several respects; in particular I pointed out that "G. R." was in error in calling Philipp Reis by the title of "Dr.," which he never possessed or used.

Instead of replying to these specific challenges "G. R." invents a lot of proofless and personal assertions. It is a matter of regret that the pages of your valuable review should be stained by anonymous slander on the deceased inventor. It is significant that "G. R." still withholds his name. This is quite enough.

* * * *

**Silvanus P. Thompson.**

Finsbury Technical College,
*October* 24*th*, 1885.

[We have thought fit to omit portions of the above letter where asterisks appear, and our columns will now be closed against the continuation of this controversy, which is bordering on the verge of abuse.—EDS. ELEC. REV.]

### Photo's from Tracings.

I should be glad if any of your correspondents could tell me it is practicable to print blue photo's from engineers' tracings by means of one of the cheap arrangements of a single incandescent light.

**Chas. Louis Hett.**

26*th October*, 1885.

PATERSON & COOPER,
ELECTRIC LIGHT AND POWER AND TELEPHONE ENGINEERS,
ST. PAUL'S WORKS—76, LITTLE BRITAIN, LONDON, E.C., AND
EUROPEAN TELEGRAPH WORKS—POWNALL ROAD, DALSTON.

Prize Medals, International Electrical Exhibitions, Paris, 1881, London, 1882, and Calcutta, 1883.
MANUFACTURERS OF
DYNAMO MACHINES, ARC LAMPS, AND ALL ACCESSORIES FOR ELECTRIC LIGHT INSTALLATIONS.

DYNAMOS.—PATERSON & COOPER'S Phoenix Dynamos for Incandescent or Arc Lighting; Slowspeed Machines for Ship Lighting; Dynamos for Electro-Deposition of Metals.

SEARCH LIGHTS.—Submarine Arc Lamps for Salvage or Fishing.

ENGINES.—High Pressure and Condensing; Steam Boilers; Turbines, Water Wheels, Overshot Breast and Undershot; Shafting, Pulleys, Plummer Blocks, Gearing, Belting, &c.

ARC LAMPS.—Licensees and Manufacturers of the Clarke-Bowman Arc Lamp, the Pilsen Arc Lamp, the "J.F.," and other lamps.

INCANDESCENCE LAMPS.—Agents for Swan, Edison, Bernstein and other incandescence lamps.

MEASURING INSTRUMENTS.—Cardew's Universal Voltmeter, Paterson's Patent Electro-magnet Am and Voltmeters, and Engine-room Ammeters; Ayrton & Perry's Am and Voltmeters, Ohmmeters, Powermeters, Tachometers, &c.

CARBONS.—"WALLACE DIAMOND" Carbons, as used at Severn and Mersey Tunnel Works, Great Western Railway Company, International Health Exhibition, &c.; HARDTMUTH'S SOFT CORE CARBONS.

FITTINGS.—Sockets, Holders, Lamp Reflectors, Brackets, Improved "R.E." and Maynard Switches; Safety Cut-outs, and all requirements for electric light installations; Cables of all descriptions.

TELEGRAPH INSTRUMENTS.—Telephones, Switchboards, Magneto Call Bells, "S.N." Instruments, Railway Signal and Speaking Instruments, Tapper Bells, &c.

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MACINTOSH LANE, HOMERTON.

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OF

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**WIRE.**—India-Rubber and Gutta-Percha covered in all gauges.

**INSTRUMENTS.**—"Morse" Relays, Single Needle, Wheatstone's Alphabetical, Semaphore "Block" Instruments, Bell Resistance Coils, Sir W. Thomson's, and other Galvanometers, Condensers, Testing Instruments, &c.

**BATTERIES.**—SOLE MANUFACTURERS FOR GREAT BRITAIN, IRELAND, AND THE COLONIES OF TH CELEBRATED LECLANCHE BATTERY, which has received the most favourable reports from the Posta Telegraph Authorities and other eminent Telegraph Engineers, and is now in general use by the Post Office an English and Continental Railways. As a Battery for all Telegraphic purposes it is undoubtedly pre-eminent. All other kinds of Batteries also manufactured. Ebonite Cells, Carbon Plates, &c.

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TELEGRAPH STORES AND APPARATUS OF EVERY DESCRIPTION.

## TORPEDO APPARATUS.

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AND OF THE

## SILVERTOWN PATENT FIRING BATTERY.

A Constant Battery for Mining and Blasting Purposes.

CONTRACTS ENTERED INTO for the SUPPLY, CONSTRUCTION, and MAINTENANCE of TELEGRAPH LINES.

MANUFACTURERS OF

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PORTSMOUTH ... ... ... 49, High Street.
BELFAST ... ... ... ... 33, High Street.
DUBLIN ... ... ... 15, St. Andrew Street.
BRISTOL ... ... ... 2, Clare Street.
NEWPORT, MON. ... ... 33, Dock Street.
CARDIFF ... Pierhead Chambers, Bute Docks.
NEWCASTLE-ON-TYNE ... 6, Neville Street.
NORTH SHIELDS ... ... Borough Road.
BIRMINGHAM ... ... Cobden Buildings, Corporation Street.